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ABSTRACT

These proceedings contain program highlights as well as 45 papers given during six sessions of the Symposium on Training of Nuclear Facility Personnel. The six sessions are entitled: (1) the training challenge; (2) influences on nuclear training; (3) the human factors--training partnership and factors affecting job performance; (4) current training methods and the training-education partnership; (5) emerging training techniques and evaluation to improve performance; and (6) measuring training's impact. Selected non-overlapping paper titles are listed as follows: "The Impact of Accreditation on Public Service Electric and Gas Company" (Hanson); Training-Related NUMARC Activities" (Holyoak); "Training and Plant Performance" (Coe); "Nuclear Training from the NSSS Owners Group Participation" (Hine); "NCR Influences on Nuclear Training" (Hannon); "Personnel Selection and Emotional Stability Certification" (Berghausen); "Application of Human Factors Design Review Principles and Data to Training" (Duquette); "Improved Human Performance through Appropriate Work Scheduling" (Morisseau); "The Training Department's Role in Human Factor Analysis during Post-Trip Reviews" (Goodman); "Non-Training Related Causes of Personnel Performance Problems" (Zaret); "Mental Models for Expert Systems to Technology of Training" (Blackman); "Situations That Can Help One to Fail an NRC Exam" (McMillen); "Utilizing a Microcomputer Based Test Bank" (Hamel); "The Role of Simulator Training in Developing Teamwork and Diagnostic Skills" (Grimme); "The Use of Videotaping during Simulator Training" (Helton); "ITC Maintenance Training Simulators" (Shilmover); "Job Relevance of Engineering and Specialized Educational Programs for Licensed Reactor Operators" (Melber); "Experiences in Solving the Challenges of On-Site Technical Degree Programs" (Christenson); " A Team Training Process for Nuclear Power Plant Technicians" (Macris); "Evaluation of Team Skills for Control Room Crews" (Gaddy); "Development of PWR and BWR Event Descriptions for Nuclear Facility Simulator Training" (Carter); "Maintenance Training" (Bushall and

Shaw); "Effective Training for the Nuclear Field Using Computers" (Forrer); "Computer Aided Video Instruction and Operational and Functional Trainers for NPP Personnel Training" (Martin); "Comparing Interactive Videodisc Training Effectiveness to Traditional Training Methods" (Kenworthy); "Accreditation Self-Evaluation" (Fritchley); "Training Effectiveness Feedback" (Wiggin); "Using Evaluation and Feedback to Improve Performance" (Ketcham); "Survey of Training's Impact" (Corfield); and "Initiatives in Training Evaluation in Industries Other than Nuclear Utilities" (Allen). (KC)

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Proceedings of the Seventh Symposium on
TRAINING OF NUCLEAR FACILITY PERSONNEL

April 27–30, 1987

Orlando, Florida

Sponsored by
OAK RIDGE NATIONAL LABORATORY

Co-Sponsored by
THE AMERICAN NUCLEAR SOCIETY—REACTOR OPERATIONS DIVISION
THE AMERICAN NUCLEAR SOCIETY—OAK RIDGE—KNOXVILLE SECTION

PURPOSE: To bring together those persons in the nuclear industry who have a vital interest in the training and licensing of nuclear reactor and nuclear fuel processing plant operators, senior operators, and support personnel for the purpose of an exchange of ideas and information related to the various aspects of training, retraining, examination, and licensing.

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PROCEEDINGS

SEVENTH SYMPOSIUM

TRAINING OF NUCLEAR FACILITY PERSONNEL

April 27 - 30, 1987

Orlando, Florida

Sponsored by:

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PROGRAM HIGHLIGHTS

Sunday, April 26

4:00-8:00	**Registration**
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Monday, April 27

Morning

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Co-Chairman: T. P. Hamrick, Oak Ridge National Laboratory

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3. Lou Peoples, Vice President, Bechel Eastern Power Corporation I.3
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THE IMPACT OF ACCREDITATION ON PUBLIC SERVICE ELECTRIC AND GAS COMPANY

H. Denis Hanson

ABSTRACT

Public Service Electric and Gas Company (PSE&G) became a member of the National Academy of Training when the last five programs for its Salem Nuclear Generating Station received INPO accreditation in November of 1985. In June of 1986, the NRC conducted a post-accreditation visit at the PSE&G Nuclear Training Center. In March of 1987, the biannual report for the first five programs to be accredited was submitted. The development and conduct of training programs, based on a detailed analysis of position task requirements, complemented with plant-specific, performance-based evaluation of trainee performance; has had a positive impact on station performance and appearance, as well as worker attitude and capability. Communication between station and Nuclear Training Department management is stronger; and a clearer understanding of the roles, reponsibilities, and accountabilities of each has occurred. Lessons learned, activities relating to the maintenance of accreditation, and the seeking of accreditation for a newly licensed nuclear plant, Hope Creek, are discussed in the paper.

INTRODUCTION

PSE&G had made a significant commitment to comprehensive training for all station workers for a number of years, dating well before the advent of a requirement for INPO accreditation. Six-month long, apprentice level training in all plant operating and maintenance positions had been occurring since 1970. This was largely generic skill training relating to both the nuclear and fossil generating stations. Contractor provided courses were also being conducted in specialized areas for operator license training, instrumentation and control (I&C) personnel, etc. As a result of the 1980 union negotiations, training at the journeyman level was begun for the electrical, mechanical, I&C, chemistry and radiation protection departments. College credit recommendations were available for a number of the courses conducted by the Company. The training staff size was increased as a result of the Company's commitment to providing this additional training.

The Company contracted for two control room reference simulators, and a 65,000 square foot training center in 1980 and 1981. Over 20% of the training facility funding was set aside for the expressed purpose of purchasing training equipment. In addition to the furniture, office equipment and similar requirements, this gave us the capability to outfit each of the shops and laboratories with an initial inventory of plant-specific training equipment. System simulators for instrumentation and control, actual count room and other chemistry and radiation protection plant equipment, and extensive electrical and mechanical maintenance training shops were established and incorporated into the training programs.

MAJOR MILESTONES

While a great deal of training was being conducted to support the stations, the training being provided had to be significantly redeveloped to meet the performance-based criteria for INPO accreditation. To make this change, relatively large modifications were required in each discipline. First, a job analysis had to be completed in sufficient detail to assure that learning objectives and materials were supportive of the comprehensive task list. Secondly, contractor provided packaged training programs were replaced by the newly hired instructional staff. They developed programs aligned to the job analyses so our instructional programs specifically related to Salem Nuclear Generating Station. A third significant impact was the incorporation of a newly acquired control room simulator for Salem into the licensed operator training programs, as well as in support of some training in other areas.

Finally and somewhat surprisingly, the most difficult challenge and change was to overcome the inertia of the training staff from its years of providing topic-based training on a generic basis, to actually accepting and owning the need to develop and conduct plant-specific, performance-based training. This required moving themselves out of the classroom and into the station procedures and processes. INPO assist visits, following initial submission of self-evaluation materials, provided a major incentive for the staff to incorporate the new instructional systems methodology and begin the significant transition towards a performance-based training system.

The demand for qualified personnel throughout the job analysis and program development period was critical. During this same timeframe, Salem experienced major equipment outages and the need to staff up to meet the operating and maintenance requirements of the newly licensed Salem Unit 2.

LESSONS LEARNED

First and foremost in the lessons learned category was to develop a reasonably effective job and task analysis (JTA) for each discipline. Our analyses were conducted prior to the availability of the industry analyses later assembled by INPO. We found that to do analyses in sufficient depth to determine the requirements for successful task accomplishment, more subject-matter expert personnel time was required than originally anticipated. We also found that a single, standardized format for a JTA was not equally effective in all job areas. Information relating to frequency, criticality, and importance to public safety, provided little useful information in either determining detailed task requirements or assisting in establishing whether the task should be trained to. For both situations, experienced subject-matter experts provided better information and judgment as to what should be included in the training programs. We ultimately used standardized job task questionnaires and sampling interviews in all job areas, but supplemented the maintenance areas with a comprehensive review of inspection orders and work orders to assure tasks performed by maintenance personnel were properly identified. We have subsequently related our task analysis and qualification cards to the maintenance procedures used at the stations and use a review of inspection orders and work orders for job task analysis validation.

As most American utilities can attest to by now, completing a comprehensive job analysis is a significant undertaking, requiring talented people. The time necessary to do an effective job can be easily underestimated if the training staff and the plant support personnel have not previously experienced the commitment required to produce such a document. Equally important to the completion of an appropriate job and task analysis is to assure that effective methods are in place so that the analysis can be maintained current. It is very important that I need not repeat the entire job task analysis process for each discipline regularly. To avoid that, I must have confidence that the JTA is being actively kept current.

A second lesson learned is that it takes a long time for an instructional staff to actually internalize a change in the training process, so that your programs reflect products of a new way of doing business. This was true of staff that had been with the Company a long time, as well as newly employed instructors. Those staff that had been with us had to overcome the significant inertia of doing things the way they had been, which in most cases they felt had been successful. New staff, in addition to understanding and incorporating our way of doing business, had the additional burden of learning our plant-specific procedures, people, and equipment. Again in this area, it is important to guard against regressing from a level of quality your staff may have achieved. Many staff members are more confortable or find it easier to conduct training programs in a standard classroom environment. Once you have them oriented to conduct as much of their training in the plant environment with appropriate mockups and models, or in shops and laboratories as practical; without continued encouragement and incentives, you will find some backsliding into doing it an easier way. Figure 1 is a taxonomy we include in our instructor training program to focus our instructional staff's mind-set, that in dealing with learning objectives or evaluation, to attempt to conduct the training at the highest performance-based level practical.

Another important lesson is the need to assure that plant staff and management, as well as, other senior management, are reasonably aware of the effort, commitment and resources required to establish and conduct comprehensive, performance-based, training. Many senior managers' view of training is the "one week" type human resource program that are non-site specific and pretty much taught out of a suitcase by one consultant trainer. This image, when translated to nuclear training, leads to a very erroneous view of the kind of lesson preparation time and research required to conduct good plant-specific training based on a systematic analysis of jobs, procedures, equipment, and operating experience. Additionally, few if any senior managers have had any direct project or management responsibility for the construction, testing, operation, and continued upgrade and maintenance of plant-referenced, control room simulators. A third area often encountered is that those senior managers with experience in military training systems with large trainee through-put, may expect trainers to produce a military-type qualification program for a system that has an annual replacement need of 2 to 4 technicians. Creatively different approaches are appropriate for these small groups when compared to systems where hundreds or thousands of trainees are processed on an annual basis.

The final lesson learned, I would mention at this point, is that the acquisition of a quality training facility and training equipment including simulators, should not lead one to assume that the training equipment or training facilities will automatically be effectively incorporated into training programs. Perhaps the outstanding challenge to nuclear training today is the effective training use of a plant-referenced control room simulator, including the evaluation of individual and team performance at the completion of training.

RESULTS

In November of 1985, Salem Nuclear Generating Station became the second plant in the United States to receive INPO accreditation for all ten programs. In so doing, PSE&G also became the second member of the National Academy of Nuclear Training. This success reflected a number of achievements. First, the realization that the Company's continuing commitment to employ people at the entry-level in its work force, and provide in-house training and education to allow employees to progress to the top of their job classifications, can be met if an equal commitment is made providing necessary training and education resources and applying appropriate standards.

As a result of the job analyses, training programs were modified significantly; in one program an extension of over two months was required. In other training programs, training time could be shortened because of overemphasis or lack of appropriateness of some training material that had been historically provided. The Company/Union Agreement has been revised as it relates to training for people in the nuclear department, and regular meetings are held by Company and Union officials to discuss changes in the nuclear training programs. Communication on a continuing basis between the station and the training organization at the management, as well as individual discipline level has and continues to be very effective.

The most important impact of achieving INPO accreditation has been the internalization of an effective personnel qualification processes. Station supervision and employees understand the use of and need for a detailed job analysis if the employees are going to be able to complete required complex work activities in a correct and timely fashion. Within the training organization, the understanding and commitment to helping employees learn what is needed to accomplish their jobs successfully, is now the center of trainers thought, rather than each trainer telling people what he/she believes is important, or sea stories from their work history which oft-times did not produce focused training of value to the trainee.

PERFORMANCE

Most importantly the operating performance of Salem Generating Station has shown continued improvement over the recent past. While there have been a number of contributing factors, certainly the qualification and capability of the people working there is one of, if not, the most important factor. While training received from a systemically developed training program is not the only variable that accounts for quality performance of people, it is certainly an important ingredient. Salem Unit 1 set a free world electric production record in calendar year 1985 for a single generating unit. In 1986, Salem conducted a refueling outage in the shortest period ever for a four-loop Westinghouse plant. External measures such as SALP and INPO Plant Evaluations are improving. Our new Hope Creek Generating Station set world records for power ascension testing and initial fuel load among all similar BWR's. All three units have begun 1987 with excellent operating performance.

The experience and lessons learned from INPO accreditation are being applied to our activities as we conduct training for our newly licensed Hope Creek Generating Station. As we continue to conduct programs for our nuclear generating stations, additional focus and definition continue to improve the quality of training we provide.

REFERENCES

INPO accreditation criteria, program guidelines and good practices. PSE&G instructor development manual, training programs and procedures, and accreditation self-evaluation reports.

Figure 1: Performance-Based Training Taxonomy

Perform
Perform similar
Simulate
Simulate similar
Demonstrate
Walk thru
Audio visual
Discussion
Read-react
Lecture

Note: Often a combination of activities is required for effective training. For fundamental training and to support enabling learning objectives, training may consist of activities less directly tied to task performance. For primary tasks, training and trainee evaluations should be accomplished with activities as near the top of the list as practical.

"TRAINING-RELATED NUMARC ACTIVITIES"

Robert H. Holyoak

NUMARC DESCRIPTION

NUMARC, Nuclear Utilities Management and Resources Committee, was formed in March of 1984 and is a confederation of 55 utilities that function day to day in the nuclear area. It's genesis was the initiative by the Nuclear Regulatory Commission staff in the proposed SECY-84-76A regulations which the NRC Commissioners were considering. SECY-84-76A covered regulations in management and people related areas, rules on training, degrees for shift supervisors, rules in maintenance activities, senior management on shift and fitness for duty. The executives of the nuclear industry did not believe that the proposed regulations were in the best interest of nuclear safety and reliability, and would have a negative impact on industry self-improvement initiatives that were underway and actually could have a negative impact on nuclear power plant operation. Enactment of SECY-84-76A would have had the effect of freezing the current INPO accreditation program, destroying the dynamics of this growing INPO program. Implementing SECY-84-76A would have caused a prudent utility industry to wait and see what the NRC would mandate instead of continuing activities to enhance programs and strive for excellence, and end up meeting only minimum standards as specified by law.

In June of 1984 industry representatives met with the Nuclear Regulatory Commission recommending that the Industry be allowed to continue the progress being made without new rule making. Commitments were made which will be commented on later in this paper and the Commission agreed to delay rulemaking in relation to SECY-84-76A in order to see what the industry could accomplish on its own.

NUMARC created a set of four basic goals as a basis of Industry initiatives, they are:

1. Perform integrated reviews of management and people-related issues; identify problems and initiate solutions.

2. Consider NRC goals in areas of industry initiatives and help the NRC avoid inappropriate action.

3. Establish and maintain a regulatory atmosphere that allows flexibility for effective management.

4. Inform members of Congress and their staff of the progress that has been achieved by the nuclear industry in improving the safety of nuclear power plants.

The NUMARC executive committee makes the final decision on issues and consists of senior utility executives from each utility.

There is a steering committee whose function is to organize industry initiatives and coordinate all activities including managementwith other industry groups, the NRC, and Congress.

The steering committee consists of the Presidents of Georgia Power, Virginia Power, Portland General Electric, Detroit Edison, and Yankee Atomic; the Executive Vice Presidents of Duke Power, APS, and Consolidated Edison; Senior Vice Presidents from Alabama Power, Arkansas Power and Light, and Northern States Power; and Vice Presidents from Philadelphia Electric and Commonwealth Edison.

Working groups are formed as needed to develop positions on specific issues.

II.2.3

Industry Commitments Made On Training Thru NUMARC

The industry commitments relating to training are the following:

1. Accreditation: That all plants operating as of December 31, 1984 would be ready for accreditation in two years. Each plant would have ten programs, making a total of 610 programs that would have to be ready for INPO accreditation by December 31, 1986.

   The 10 programs are:

   Non-Licensed Operator
   Reactor Operator
   Senior Reactor Operator
   Shift Technical Advisor
   I&C Technician
   Electrical Maintenance
   Mechanical Maintenance
   Radiological Protection
   Chemistry Technician
   Technical Staff and Managers

2. Control Room Operator Professionalism:

   The industry committed to enhance the professionalism of control room operators. This commitment partially evolved out of Senator Monahan's comments after a visit to a utility control room that the reactor operators were indistinguishable from a group of gas station attendants. Part of the enhancement of professionalism was for INPO to include senior reactor operators from other utilities as peer evaluators on each of their plant evaluation teams to assist in evaluating on-the-job and simulator performance of licensed operator activities. The evaluators from other utilities help with the effectiveness of the evaluation process, but also create a level of professionalism by having senior reactor operators from one plant visit another plant and see how they operate.

3. Improving Diagnostic Capabilities of Shift Personnel

The industry committed to improving the diagnostic capability of shift operating personnel. This was to address a concern of the NRC that all shift supervisors or even all control room operators should have technical degrees. The commitment was to upgrade the training in engineering fundamentals so that shift personnel would have the capability to diagnose abnormal situations.

4. Shortage of Qualified Personnel

NUMARC addressed the problem of the shortage of qualified personnel at nuclear utilities and the excessive use of consultants. Each utility would develop plans to minimize the use of contracted personnel in permanent positions.

5. Fitness for Duty

The industry committed to having a fitness for duty program in place by January 31, 1985 which covered aberrant behavior, and chemical substance abuse at nuclear stations, based on the EEI "Guide to Effective Drug and Alcohol Policy Development".

6. License Requalification Program

NUMARC set up a working group to clear up problems with the NRC conducted license requalifications.

7. Conduct training workshops of SROs selected to participate in SRO peer evaluator programs.

The industry committed the utilities to supply SRO peer evaluators on each plant evaluation and NTOL assistance team. A program of workshop training for these people was committed.

NUMARC Accomplishments in Training

NUMARC since its inception in 1984 has in conjunction with INPO made a remarkable amount of progress in the training area. The major accomplishment has been that working thru INPO, of meeting the commitment of preparing 610 programs for accreditation within the nuclear industry. We all know how difficult and expensive it was to do this commitment within the tight time table.

Efforts to improve control room professionalism has made good progress. These efforts range from the wearing of uniforms to improvements in simulator training techniques and this is an ongoing effort.

Diagnostic capability was incorporated into the operating accreditation format with the result that operator initial and requalification includes exposure to diagnostic techniques and fundamentals.

An example of meeting this requirement is what we do at the Commonwealth Edison Production Training Center during license and requalification training. We teach diagnostics thru all normal and casualty operations but introduce diagnostics as part of control room skills training which includes Team Building and Communications.

Diagnostics is structured similar to many available commercially availablek programs, such as Kepner Traego, BPI or Alamo and others. Specific classroom exercises introduce diagnostics with made up scenarios with forced data that bring the students to a common conclusion. Then actual event scenarios using strip charts from recorders, questions on a group basis that lead to conclusions. This is augmented with diagnosis on the simulator in real time. This demonstrates to the operator that the designer organized the plant systems with problem analysis in mind and that logic type systems do much of the work for you. This could be defined as a "class A", diagnostic where problems are self identified by the plant systems. We work on the, "class B", diagnostics where the operator has to analyze and work out the problem. One interesting exercise we do is to take an operating procedure and translate it line by line into diagnostic English. This acts to clarify many things for the operator.

Utilities have committed to support NUMARC in reducing the excessive use of consultants by filling permanent positions with utility staff.

Some of the steps taken include:

1. Establish a human resource management system covering personnel activities relevant to nuclear staffing.

2. Support and encourage efforts of area educational institutions to increase availability of local personnel with solid basic training at the entry level.

3. Work with area educational institutions to develop continuing education programs for utility employes that are directly relevant to nuclear staff qualifications and job progress.

The industry committed toa fitness for duty program and this program is in place.

Again I would like to use Commonwealth as an example. We started our first fitness for duty program in 1984 with a program entitled "Awareness" which covered aberrant behavior, alcohol abuse, drug abuse and the Edison Employee Assistance Program. The next program called "Preparedness" about eighteen months later covered the same areas with the addition of stress control and anger management and control. "The current program is being put together and is a reiteration of the previous programs with stress on Edison's experience and policy in the area of drug and alcohol abuse.

Another effort at the request of the utility industry has been a coordinated effort to work with the NRC in the area of license requalification exams. Considerable concern existed relating to the NRC approach to their administration of license requalification exams on a random basis. The industry in general considered the NRC intrusion into an area, that the utilities considered adequate, disruptive and the tests in some cases unfair.

The committee under John Griffin of Arkansas Power has worked with the NRC to set up a pilot program where the NRC would be involved in overseeing a utility conducted requalification exam. To date this approach has mixed reviews and the pilot program has been extended until the end of 1987.

The bottom line is that NUMARC since its inception since 1984 has had a major impact on training. By working with the Institute of Nuclear Power it has moved the nuclear utility training systems ahead in time, doing in two years what would have taken a lot more time. The existence of a central directorate with the industry INPO organization has allowed Nuclear Utilities to be quickly responsive to the initiative of NRC and the public.

A statistical impact of the growth of training within the utilities in the training area since the advent of NUMARC can be seen by looking at the April 1984 and September 1986 reports from INPO "Survey of Nuclear - related Training Activity in U.E. Electric Utilities". By January 1986 training space in the nuclear utilities had increased by 45% over March of 1984. The number of staff in nuclear training activities increased 85% by January 1986 over March of 1984.

NUMARC AND TRAINING, THE FUTURE

NUMARC has several training initiatives before it. The NRC commissioners Zech, Bernthal and Asselstine have pressed NUMARC to improve industries maintenance activities. Part of that improvement will center on maintenance training and factoring industry experience into that training.

In operator requalification as mentioned, the pilot program with the NRC has been extended and a final recommendation will be made to the Commission in mid-1987. The working group will be meeting with staff to review the advantages and disadvantages of the pilot program and discuss ways to improve this approach.

NUMARC has modified the view on the check operator to that of Independent Evaluator. A survey of the Industry last fall attempted to get consensus on who does the evaluation, who acts on them, and is it an effective process. These results will be discussed with the NRC staff.

UNPOC

Now let me discuss the reorganization of the nuclear industry organizations under the leadership of UNPOC, kthe Utility Nuclear Power Oversight Committee.

UNPOC evolved from an ad hoc group formed in April 1979, to coordinate and oversee the electric utilities' response to the Three Mile Island accident. The original committee was responsible for forming the Institute of Nuclear Power Operations (INPO), the Nuclear Safety Analysis Center at EPRI, and the U.S. Committee for Energy Awareness.

UNPOC presently includes utility representation from the following associations: The American Nuclear Energy Council (ANEC), the American Public Power Association (APPA), the Atomic Industrial Forum (AIF), the Edison Electric Institute (EEI), the Electric Power Research Institute (EPRI), the Institute of Nuclear Power Operations (INPO), the National Rural Electric Cooperative Associate (NRECA), and the U.S. Committee for Energy Awareness (USCEA). It has served as a forum for issues to be considered at the highest executive level for fostering coordination of our industry organizations. The present Chairman is Jim O'Connor - chief executive officer at Commonwealth Edison.

As a result of the UNPOC-sponsored study, a report was issued last year entitled: "Leadership in Achieving Operational Excellence". The report has three sections one of which called for the establishment of a new, unified nuclear industry organization to be the single industry voice on regulatory issues. This is the section I will discuss briefly, because of its continuing impact on training.

The new organization will be responsible for coordinating all matters involving industry-wide regulatory policy issues and ont the regulatory aspects of operational and technical safety issues affecting the industry.

The new organization will be free-standing and independently funded and will operate under the concept of NUMARC -- namely, it will be an organization run by the 55 nuclear utilities as opposed to by the vendors.

However, the new organization will draw on the collective expertise of other industry groups such as architect-engineers, vendors, and other supplies and involve those groups in the regulatory issues to be addressed.

The new organization will be governed by a board of directors composed of senior executives from each utility that is building or operating a nuclear plant. It will be very similar to the current NUMARC executive group. The industry's position on regulatory issues will require an affirmative vote by at least 80 percent of the members such as NUMARC. The new organization will have a permanent staff located in Washington, D.C. which would have responsibility for the day-to-day interface with the NRC.

Now, let me give you a quick, short course on the reorganization.

The utility Nuclear Power Oversight Committee (UNPOC) will be renamed. Its board will be expanded to include more chief executive officers of utilities. It will be permanently headquartered and staffed as required. Under this new constitution, UNPOC will assume responsibility for strategic planning, coordination, international cooperation, and the policy leadership of the nuclear utility industry. This will enable the oversight committee to coordinate and oversee directly the organizational efforts that are now carried out by AIF, ANEC, NUMARC and USCEA. The American Nuclear Energy Council (ANEC) which was formed in 1975 and is the governmental affairs arm of the utility, the Atomic Industry Forum which was formed in 1953 and handles much of the public affairs and technical interface with the NRC and the U.S. Committee on Energy Awareness which was formed in 1983 and has responsibility for public information on nuclear power, will undergo a structural realignment to concentrate their collective resources and capabilities in three basic areas.

1. Regulation and technical support;

2. Communication, education and technical services; and

3. Government affairs.

Each of these three reconstituted associations will be organized with its own board of directors, president and full-time staff.

This reorganization will be completed and implemented by July 1, 1987.

Among other considerations, this reorganization of the nuclear utility industry is expected to include a merger of the USCEA and AIF minus AIF's regulatory and technical support functions which will merge with the functions of NUMARC. ANEC will continue to carry out the government affairs functions.

As called for in the UNPOC report, this new, unified industry organization will attempt to interface with the NRC in a nonadversarial manner.

TRAINING AND PLANT PERFORMANCE: A STRATEGIC PLANNING PARTNERSHIP

GPU NUCLEAR CORPORATION
Dr. Richard P. Coe
Director - Training and Education

ABSTRACT

To no one's surprise, U.S. nuclear utilities and their training groups are on a collision course. The course is bringing dangerously close the potentially opposing forces of the industry's commitment to excellence and the public's relentless pressure for cost effectiveness. As operational costs continue to escalate, the cost of replacement power adds to the mounting pressure on the nuclear option.

The industry as a whole, and specifically GPU Nuclear, is refocusing its attention on performance indicators. This standardized assessment of plant operational performance surfaces numerous examples of how performance-based training positively impacts plant performance. Numerous examples of high dollar savings range from scram reduction programs to reducing personnel rem exposures. The deeper we look the more we find that training is making a difference. The question now is, how long can we continue to afford the ever increasing demands of the pursuit of excellence.

Early in 1985, the Training & Education Department at GPU Nuclear proactively began its strategic planning effort in order to address the increasing industry initiatives while facing flat or reduced commitments of resources. The Training Strategic Plan addresses detailed plans for each of the following areas:

- Curriculum Planning
- Program Development
- Training & Education Organizational Structure
- Training & Education Administrative Procedures
- Training Advisory Structure and Priority Process
- Financial Strategies

All of the above strategies are designed to assure training effectiveness. With the nuclear option under such strong public scrutiny, it is in the best interest of all of the nuclear utilities to assure the most cost effective approach to successful operation while achieving our standards of excellence.

II.3.2

COST VERSUS THE PURSUIT OF EXCELLENCE: COMPATIBLE OR INCOMPATIBLE?

To no one's surprise, U.S. nuclear utilities and their training groups are on a collision course. The course is bringing dangerously close the potentially opposing forces of the industry's commitment to excellence and the public's relentless pressure for cost effectiveness. As operational costs continue to escalate, the cost of replacement power only adds to the mounting pressure on the nuclear option.

The industry as a whole, including GPU Nuclear, is refocusing its attention on performance indicators. This standardized assessment of plant operational performance surfaces many examples of how performance-based training positively impacts plant performance. Examples of high dollar savings range from scram reduction programs to reducing personnel rem exposures. The deeper we look the more we find that training is making a difference.

Led by utility initiatives in the form of the Nuclear Utility Management and Resources Committee (NUMARC) and the recently formed Utility Nuclear Power Oversight Committee (UNPOC), a standardized assessment process will be applied to plant operational performance. This process uses nine measurable performance indicators. Plants report to INPO in terms of these indicators and based on their performance, nuclear units will be rated from "excellent" to "requires special attention and assistance."

These indicators include:

- Number of significant events per unit
- Number of unplanned automatic scrams
- Personnel exceeding 5 REM at one facility
- Collective radiation exposure per unit
- Low-level solid radioactive waste per unit
- Forced outage rate
- Lost time accident rate
- Thermal exposure
- Equipment availability

Since fully implementing our Training Systems Development (TSD) process, we have identified numerous instances of training having a positive and measurable impact on plant performance. Plant shutdowns were avoided, personnel exposures were significantly reduced and costly call-outs were avoided resulting in large visible dollar savings. Some of the examples are:

- ° At Oyster Creek, plant scrams had been experienced due to Nuclear Instrumentation (NI) interlocks with the Reactor Protection System (RPS). Training was designed and implemented on the NI and RPS interlocks both in the classroom and on the simulator. Since this training has been implemented no new scram incidents have occurred. THIS SAVES $400,000 PER DAY FOR REPLACEMENT POWER AND ADDITIONAL CALL OUT COSTS.
- ° At Oyster Creek, operation of the Turbine Control system had been a source of recurring problems. A vendor simulator, which had been used as the simulator for operator training, used a system which was very different from Oyster Creek's. Another simulator with a turbine control system more like the one at Oyster Creek was evaluated and selected. Since switching over to this simulator, the company has noted a significant improvement in operator performance on the turbine control system.
- ° At Three Mile Island (TMI), operational upsets and problems had been induced by failures and transients in power supplies and instrument input signals to the Integrated Control System (ICS). This is common in B&W plants. As a result of training designed and implemented by the operator training section, two of the newest operators were able to properly respond and manage an ICS power failure while the unit was operating at 100% power. The plant was able to stay on line at the 100% power level as a direct result of their actions. THIS SAVED $400,000 PER DAY IN REPLACEMENT POWER AND ADDITIONAL CALL OUT COSTS.
- ° At TMI, severe reactor imbalance and soluble boron/rod position control problems, as experienced at other similar plants, were avoided during startup. This was directly related to the

awareness and specific pre-startup training which was designed to manage this problem.

- At Oyster Creek the pre-drywell entry orientation training was directly responsible for reducing the accumulated dose to QA inspectors by a factor of two. The training consisted of a short videotape which showed work areas in the drywell model and still photographs of the model. This approach reduced inspection time and improved work planning. The job had been estimated at 32 REM and actual total exposure was only 14 REM. THIS IS A 56% REDUCTION FROM THE ESTIMATED DOSE.

It is clear from these examples that training is making a difference. Using our Training Systems Development (TSD) approach we are confident that many more innovative approaches to training problems will be developed as problems in the plants arise. The question now is, how long can we afford to pursue the ever increasing demands of the pursuit of excellence without training becoming too big or too costly to afford?

A POSSIBLE SOLUTION

The answer lies in how Training Management plans for the future. Early in 1985, the Training & Education Department at GPU Nuclear proactively began its strategic planning effort in order to address the ever increasing industry initiatives while facing flat or reduced commitments of resources. The Training Strategic Plan addresses detailed plans for each of the following areas:

- Curriculum Planning
- Program Development
- Training & Education Organizational Structure
- Training & Education Administrative Procedures
- Training Advisory Structure and Priority Process
- Financial Strategies

Curriculum Planning

Our curriculum architecture organizes various training needs into a logical sequence of programs or modules. It provides a blueprint to help and assign priorities in developing and maintaining training programs. Prior to embarking on the curriculum design process, a detailed project plan is developed for each curriculum project which includes estimates of the cost to develop the curriculum and a statement of the business benefits to be gained. Project proposals are prepared for review and priority setting by the advisory structure.

Program Development

The program development process, as spelled out in our Program Development Manual (PDM), is the means for creating training programs that directly support job performance. Training has received corporate-wide support endorsing the use of this process in all areas. Specifically in Training we have:

- Established program development resource levels to enable high quality program development
- Implemented a Curriculum Coordination capability among the three sites
- Implemented a project planning and budgeting system for program development
- Further strengthened the linkage with user organizations regarding content by a more consistent use of the Technical Content Review groups
- Implemented an expanded training advisory structure to assure proper attention and a corporate-wide consistency
- Developed and instituted a process to augment our instructor staff with plant personnel on special assignment.

Training and Education Organization Structure

A revised organization structure is proposed for the Training and Education Department to more efficiently and effectively carry out its mission and roles.

Specifically, we have:

- Created new program development capability at each location
- Removed some program development responsibilities from the delivery groups
- Changed some of the mission and roles of the Educational Development Department
- Added more responsibilities to the training administrative support group
- Provided expertise to help develop training.
- Consolidated certain functions
- Instituted rotational assignments to better distribute and develop expertise

Training and Education Administrative Procedures

Several administrative systems have been identified which make major contributions to improvements in both efficiency and effectiveness of training. Some of these systems are the:

- Establishment of a uniform Training and Education Data System to measure overall training results and costs
- Revision of the Training and Education Budget to separate program development from program delivery for priorities and budget
- Establishment of a uniform registration and scheduling system

II.3.7

Advisory Structure and Priority Process

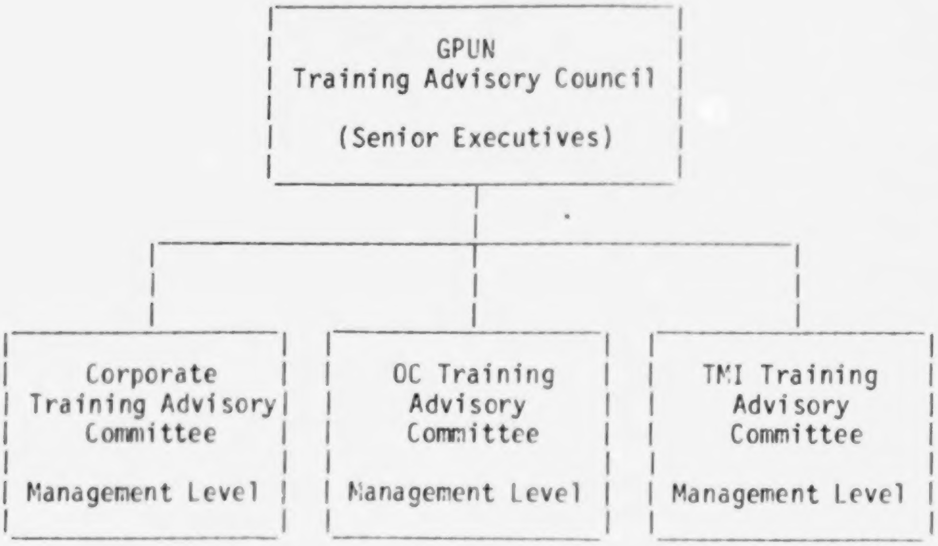
In addition to the existing Corporate Training Advisory Council, an expanded advisory structure is planned which will incorporate a new priority-planning process. The roles of the overall advisory structure will be to:

- ° Provide general guidance and direction to the training function
- ° Identify needed training programs
- ° Assure that training is meeting overall organizational needs
- ° Provide assistance in the identification of additional resources
- ° Assist in setting priorities for training programs

While there are good formal and informal linkages between training and line management at all levels, there is currently no corporate-wide mechanism for setting priorities.

The Proposed GPUN Training and Education Advisory Structure is shown on the chart below.

GPUN Training Advisory Structure


GPUN
Training Advisory Council
(Senior Executives)
Corporate Training Advisory Committee
Management Level
OC Training Advisory Committee
Management Level
TMI Training Advisory Committee
Management Level

Financial Strategies

Through January of 1986, all of the Training and Education activities had been financed through a centralized Training and Education budget. The line organizations (because of numerous external initiatives) have been placing increasing pressure on this budget. In the future, various mechanisms will be established to further share the burden of training costs between Training and Education and the users. Beginning in 1987:

- Any additional initiatives requested by the user department must be funded by the requesting department.
- Working with the Advisory Council, a phased-in approach will be developed for sharing development and delivery costs, particularly for discretionary programs.
- Training developed and used a charge back system for selected programs.

SUMMARY

All of the above strategies are designed to assure training effectiveness. Our intent is to reduce the amount of time in training without affecting quality, to provide the necessary blend of internal expertise and staffing levels, and to reduce the overall cost of training. In addition, we will be establishing a priority process for training and thus be able to handle new initiatives.

I do not think it is a question whether or not to do strategic planning, but that present and future events will dictate to us how much we will have to do. What I have tried to share with you is a brief overview of the efforts of GPU Nuclear's Training Management who are commited to the ongoing needs of their nuclear sites and the industry-wide effort toward the pursuit of excellence. Any plans for the future will obviously have to remain dynamic and flexible.

Training professionals are going to have to constantly challenge themselves in order to assure this crucial ongoing support of the nuclear option. We will also have to be constantly aware of the need to rapidly accommodate new initiatives. Regulators, public advocates, a skeptical public - indeed - the industry itself will not allow us to adopt goals of status quo. I'm confident that our efforts at GPU Nuclear have put in motion a process that will assure our ability to successfully meet these future challenges.

GPU Nuclear's aim is to place TMI-1 and Oyster Creek in the front ranks of the U.S. operating nuclear plants. With the nuclear option under such strong public scrutiny, it is in the best interest of all of the nuclear utilities to assure the most cost effective approach to successful operation while achieving our standards of excellence.

NUCLEAR POWER PLANT TRAINING FROM THE INSURERS VIEWPOINT

John A. Honey

ABSTRACT

American Nuclear Insurers and Mutual Atomic Energy Liability Underwriters (ANI/MAELU) provides the liability insurance policy that responds to the Price Anderson Act. The policy covers liability claims brought by the general public and third party radiation workers resulting from operation of a nuclear facility. We all recognize the important role training plays in the continued safe operation of nuclear power plants. Training also plays a key role in liability claims evaluation and their defense. This paper deals with the importance of training programs in reducing the number of liability claims and the defense of those claims. ANI/MAELU has some unique concerns in that regard.

American Nuclear Insurers and Mutual Atomic Energy Liability Underwriters (ANI/MAELU) are insurance pools that represent approximately 250 member insurance companies that provide liability and property insurance for the nuclear industry. The staff of the Nuclear Engineering Department at ANI/MAELU, are responsible for nuclear liability risk assessment and reduction for the insurance Pools. These risk reduction efforts are designed to both reduce the number of claims and to place the Insurance Pools in a better position to evaluate claims and, if necessary, to provide the just defense of the claims. Nuclear power plant training plays an important role in this risk reduction effort.

Nuclear liability insurance is provided by the Pools for many types of facilities including power reactors, fuel fabricators, research reactors, waste burial sites, nuclear laundry facilities and some manufacturers of products using nuclear materials. The insurance policy at power reactors meets the financial protection requirements of the Price-Anderson Act. Among other things, the nuclear liability policies issued by the Pools include an omnibus insured provision which acts to channel all claims for nuclear liability coverages to the Pool issued insurance policy for all activities undertaken at the facility by all parties. The ANI/MAELU nuclear liability policy therefore responds to claims brought by the general public or third party workers alleging bodily injury or property damage resulting from operation of the nuclear facility.

Why is the ANI/MAELU Nuclear Engineering Department concerned with nuclear liability risk reduction? One could argue that there are many regulations governing the operation of nuclear facilities designed to protect the general public. If the nuclear facility operates within these regulations, the public is protected by definition and therefore they have no grounds on which to file a claim. Unfortunately, that argument is not supported by reality.

Since the inception of the Pools in 1957 there have been 122 incidents that resulted in claims. Thirty-nine of those incidents occurred prior to January 1, 1979. Over two thirds of the incidents resulting in claims have occurred in the last seven years of the insurance Pools' thirty years of existence. I propose there are three primary factors that are responsible for that recent upsurge in claims. These are notoriety, the age of the industry and the number of workers in the industry.

Notoriety is the factor which most precisely defines the "turning point" in claim trends, since that point coincides within a few months with the Silkwood trial and the events at Three Mile Island. In addition to these well known events, of course, are such controversies as the Mancuso Study at Hanford; the Najerian study of Portsmouth Naval Shipyard; the Bross report on the Tri-state Data; the "SMOKEY" incident and the much publicized pronouncements of anti-nuclear activists. Although it cannot be precisely established to the satisfaction of all, a prudent person would consider such publicity as having adverse impact on claim trends.

The age of the nuclear industry is a factor that becomes more important each year owing to the increasing age of the work force. The older a worker becomes, the higher the probability for a naturally occurring cancer - and it is a reasonable assumption that some in the nuclear workforce who develop cancer will attempt to make a claim against the nuclear industry, regardless of the cause of his cancer. Perhaps, the same may be true of members of the public living near nuclear facilities.

Finally, the increasing number of facilities and larger number of workers per facility will, as a matter of probability, increase the number of claims in the future. The degree to which this will be true depends largely on the effectiveness of the first two factors in producing new claims. In fact, there is a very strong relationship among these three factors. The importance of these three lies in the fact that they can only become worse from the insurance viewpoint: the bad publicity is already occurring (and may well get worse); more and more workers will develop natural cancers as the industry ages and the number of workers will continue to increase for many years.

In my opinion, many of the claims to date have questionable technical validity. I am sure most of us assembled here would not expect radiation exposures of a few millirem or plant discharges well below regulatory limits to result in claims. To the contrary, they have resulted in claims, the more interesting of which are illustrated in Table 1.

Unfortunately, it is not the responsibility of engineers or scientists to pass judgement on the validity of present or future suits for bodily injury or property damage. Juries made up of members of the general public make those judgements. They tend to be more sympathetic to the claimants than to the nuclear industry.

As I mentioned earlier, there are things we can do to improve the situation. We can strive to reduce the number of incidents that can lead to claims by improving the performance of power plants. Also we can put ourselves in a better position to evaluate and defend claims. I am sure that we all appreciate the role of training in improving the performance and hence the safety of nuclear power plants so I have chosen to limit my comments on that aspect. The combination of the INPO Training Accreditation Program and the adoption of unit specific simulators should contribute to an increase in the quality of training received by plant operators and concurrently decrease even more the frequency of incidents that might give rise to nuclear liability claims.

I would like to concentrate on the importance of training in claim defense. One of the major allegations of claimants is that they were not properly warned of the radiation hazard or properly instructed on how to protect themselves from it. Good training programs not only aid in reducing the number of incidents that may lead to claims but aid in the defense of claims that result. It is important to be able to demonstrate worker competence through a good training program and be able to show that the worker had maintained his/her qualifications. If an incident were to occur at a time when an operator's qualifications had lapsed or after he/she had demonstrated a lack of qualifications then claims associated with that incident may prove difficult to defend.

Allegations are often made that an employer did not care about the health and welfare of his employees. An excellent and well documented training program provides sound evidence to refute such an allegation.

ANI/MAELU inspects all of the commercial nuclear power plants in the country. One of the areas we review are training programs because of their importance in claim defense and evaluation. I would like to devote the remainder of my talk to some of the specifics we look for. As I mentioned earlier, there are two areas of concern. These are claims brought by nuclear workers alleging personal injury from radiation exposure and claims brought by the general public alleging personal injury and/or property damage from the release of radionuclides. The first concern is partially addressed through General Employee Training which provides sufficient warning of hazards and adequate training in safe procedures for dealing with those hazards. It is important to be able to reconstruct the training each worker received and prove that he received it and was given the opportunity to be effectively trained. Therefore we recommend that the syllabus or lesson plan containing topical outlines be retained. Since much of the instruction may be presented orally, an exact transcript of the material is often not possible. These documents should show the effective period of use. They should be treated as controlled material with retention of the master copy of each revision.

Appropriate passing grades should be established as a requirement for the successful completion of the radiation protection portion of the GET examination. Where the radiation protection examination is broken down into separate sections, each section should be passed. Persons requiring re-examination should not be allowed to take the same exam twice. Examinations covering radiation protection subjects should be reviewed formally with students to clear up any misconceptions of rules, concepts and practices. The review should be documented by the trainee's signature which acknowledges the review and the opportunity to ask questions.

GET refresher training should be conducted annually. Examinations which measure proficiency in radiation protection may be used in lieu of the refresher training. However, refresher training should be conducted biennially on changes, problems, and new policies. If an individual fails the annual examination, unescorted access should be withdrawn immediately. Such individuals should receive the complete initial GET-radiation protection training program and pass another examination prior to reinstatement of their unescorted access. If an individual was allowed unescorted access after he had failed an examination on the subject and then alleged injury due to radiation, it may be difficult to establish that a reasonable effort had been made to protect him.

Any person touring the facility on an infrequent basis is a casual visitor, and even though escorted, presents a concern to the liability insurance Pools. It does not seem reasonable to devote the time and effort of GET training but something should be done to warn visitors of the radiation hazard and assure their protection while on site. Therefore it is prudent to instruct visitors in the following:

a. Warning of the potential hazards associated with entering radiation and potentially contaminated plant areas.

b. Radiation zones and signs used to warn of the potential hazards.

c. Proper use of protective clothing (if required for entry).

d. Proper use of step-off pads (if required).

e. Escorted individuals should not be separated from escorts. If an emergency requires that an escort leave, the escort should give instructions to the escorted individuals to proceed to the nearest assembly point.

Also escorts of casual visitors should have sufficient training to assure that the casual visitor is protected in all areas of the facility to be visited.

Another concern arises in relation to female employees. Due to the increased susceptibility of unborn children to radiation; female employees, their supervisors, and co-workers should receive instruction concerning prenatal radiation exposure. Receipt of this training should be documented.

Our second area of concern is claims brought by the general public alleging personal injury and/or property damage from the release of radionuclides. The frequency and amount of releases during normal operation and especially upset conditions are strongly related to the proficiency of the operators. Training obviously plays a significant role in developing and maintaining that proficiency. We are very pleased with the progress made in this decade with regard to licensed and non-licensed operator training. The increased use of plant specific simulators, the INPO Accreditation Program and training based on job task analyses are very significant. However, there is one issue dealing with requalification examinations that deserves note. If an operator fails a requalification examination, we have recommended that he should be immediately removed from the watch bill until he can again demonstrate his qualification. We have taken this position for two reasons. His knowledge of the facility and its operating procedures has become less than desired. He could cause or contribute to an incident that directly or indirectly results in increased releases and a claim by a member of the general public. Such a claim could allege negligence on the part of the utility for allowing the operator to continue operating after he has demonstrated a deficiency in his qualifications.

In summary, the nuclear insurance Pools have some unique concerns that we are pursuing regarding third party nuclear liability claims and the evaluation and possible defense of those claims. Power plant training programs and their documentation play an important role in the Pools risk reduction effort. We are pleased with the improvements made in training programs at nuclear power plants and will continue to work with the nuclear industry in implementing training program improvements.

Table 1. Claims of Interest

Quantity	Category	Allegation
43	Chronic Exposure	Radiation Exposure
20	Negligence in Operation	Failure to follow procedures Negligence in Maintenance, Operation, and Inspection
17	Exposure of Public	Plant Releases
17	ALARA Program	Negligence in Controlling Exposure
15	General Employee Training	Failure to Train Employees Failure to Warn of Health hazard
11	Due Care	Conscious indifference to welfare and rights of worker
8	Technical Overexposure	Exceeding Regulatory Limits

TRAINING BENEFITS FROM NSSS OWNERS GROUP PARTICIPATION

R. C. Hine
J. E. Jones
K. C. Ruzich

ABSTRACT

Even though the event at Three Mile Island was a bleak moment in the history of nuclear power, many advances in the nuclear industry have evolved as a result. One such advancement involves the establishment of NSSS Vendor Owners Groups. These groups were organized on a voluntary basis with nearly all utilities participating. The main purpose was to achieve mutual benefit, both technical and financial, through joint engineering and plant operation programs. This paper focuses on the Westinghouse Owners Group, which is commonly referred to as the WOG, and how it has benefited and could further benefit utility training. The paper consists of three sections. The first section provides an overview of the WOG structure and how it functions. The second section focuses on the major accomplishments of the WOG with emphasis on the development of the Emergency Response Guidelines (ERGs). The third section provides some recommendations as to how utility training departments can better utilize their owners groups.

WESTINGHOUSE OWNERS GROUP STRUCTURE AND FUNCTIONS

The Westinghouse Owners Group (WOG) was founded in June, 1980. Presently 100 percent of the domestic Westinghouse plants (totaling twenty-five utilities either operating or under construction), seven international utility consortiums, and Westinghouse are members of the WOG.

The WOG consists of utility representatives from which officers, committees, and working groups are selected. The structure comprises the Steering Committee, technical subcommittees, and working groups as shown in Figure 1. The Regulatory Response Group (RRG) and the Issues Review Group (IRG) provide rapid response to industry and regulatory issues. The Executive Advisory Committee (EAC) assists and supports the WOG organization with executive utility management influence and advice. The W Planning Board (WPB) provides Westinghouse management counsel on technical issues suitable for WOG involvement.

The WOG functions primarily through the Steering Committee that receives input from WOG utility members, Westinghouse, the WPB, the RRG, the IRG, and the Nuclear Regulatory Commission (NRC). Input from the various groups is carefully reviewed by the Steering Committee. If this committee determines that an issue requires further study and evaluation, it will assign an appropriate WOG subcommittee to do the work. The subcommittee further reviews and evaluates the issue and makes recommendations as to how to resolve it. The recommendations can include programs that may be funded by the WOG in order to adequately address the issue. Any program or programs that are endorsed by the subcommittee are returned to the Steering Committee for additional evaluation and review. If the Steering Committee endorses the programs submitted by the subcommittee, then they are presented at the next WOG General Session where they are voted upon by individual utility representatives.

A two-thirds majority vote is required to approve any program for funding. Only the domestic utility members have voting rights (twenty-five votes total); Westinghouse has no voting privileges. Given a majority vote, the program is then supported by the full WOG membership with few exceptions. This unanimity of the WOG membership is desirable. It it ensures more active participation from the full WOG membership because the program is important and generic to all utility members. Also, an important aspect of this process is that the WOG represents its entire membership to the NRC on any of the approved programs. After a program is passed by the two-thirds vote, the Subcommittee that submitted it is tasked to direct and monitor the program to completion.

The WOG membership financially supports WOG administrative activities with an annual stipend for this purpose, i.e., project management. The funds for individually approved programs are allotted at the time of approval by the WOG. Each WOG member utility pays a fraction of the total cost of the programs based on its number of shares (one or one-half) as compared to the total number of shares. The total number of shares is equivalent to the total number of utility voting shares plus the seven half international shares plus three shares from Westinghouse for a total of thirty-one and one-half shares. A utility share can be exempted from paying for a given project if an exemption is approved by a two-thirds vote of the WOG membership.

There are some cases where the WOG also allows the development of specific, nongeneric programs that are applicable to less than a majority of the membership. These programs are funded only by the participating utilities.

In conclusion, the WOG functions with a deliberate and formal process when implementing programs. This process consists of frequent checks and balances in order to maximize the overall benefits of any funded programs. It also attempts to use the considerable resources available within the member utilities to the greatest extent possible.

II.5.4

Steering Committee

The Steering Committee can be considered the spear head of the WOG. It consists of the Chairman and Vice Chairman of the WOG, the Chairman of the RRG, and the Chairman of each subcommittee. Refer to Figure 2. Each member of the Steering Committee is a utility representative selected by the WOG membership. The Steering Committee functions as a filter in the review of all input. If the input has a generic application to the WOG, then the Steering Committee assigns the most appropriate subcommittee to review it. Most input that is not reasonably applicable to the majority of WOG membership is discarded. The Steering Committee has the following responsibilities:

- Review and/or recommend issues to be presented to the full membership of the WOG
- Review the results of the technical subcommittee evaluation of issues prior to presentation to the full owners group
- Recommend policies to be presented to the WOG
- Meet prior to a WOG meeting to formulate recommendations
- Perform a strategy and planning function that reviews potential future issues; provides integration of planning; monitors consistency between owners groups, the NRC, and industry; and interfaces with other owners groups, Institute for Nuclear Power INPO, and NUMARC
- Review the establishment of additional subcommittees, and set priorities for all work efforts

- Review the establishment of technical subcommittees for nongeneric issues, and coordinate and set priorities of the activities of the subcommittees

- Determine methods for funding specific efforts requiring additional work to envelop all plants

- Determine technical and financial participation by a new member for work previously performed

- Report once a year on the status of the WOG activities to the EAC

Groups Providing Input to the Steering Committee

Many problems and issues experienced by one utility are common to other utilities. Utility WOG members can input their concerns and issues to the Steering Committee for review and possible funding by the WOG as a generic issue. The WOG provides a cost-effective means to address common plant issues and problems.

Westinghouse Electric Corporation also provides input to the Steering Committee concerning issues generic to WOG members. Because of Westinghouse's involvement with the utility plants, it has a large pool of engineering information and expertise that can be very beneficial in identifying generic issues that affect all WOG member utilities. It also has the expertise to resolve many of the issues funded by the WOG.

The EAC provides easy access to executive management support from member utilities. Acting primarily through their annually elected Chairman and Vice Chairman, this committee has the responsibility of keeping abreast of the WOG's overall direction and program objectives. The committee is also available to assist the RRG and the subcommittees in any discussion needed with higher level NRC management or the NRC Commissioners.

The RRG is a quick-response organization within the WOG that provides inputs to the Steering Committee regarding regulatory matters. It functions to provide the NRC with positions or immediate actions on potential generic plant safety concerns. The RRG membership also includes the Chairman and Vice Chairman of the EAC who serve as advisory members.

The WPB consists of Westinghouse middle-management personnel. It was established in late 1985 with the objective of providing counsel to the WOG Steering Committee in the review and prioritization of generic issues for potential WOG involvement. Strategic areas addressed by the group include improved plant availability, improved maintenance practices, performance optimization, and regulatory improvements.

The IRG consists of the WOG Chairman, Vice Chairman, RRG Chairman, and the appropriate technical subcommittee Chairman. This group is responsible for disposition of industry issues requiring expedient resolutions, e.g., the Davis Besse Incident.

The technical subcommittees provide support to the Steering Committee by extensively evaluating issues identified as being generic to the WOG members and by monitoring their respective programs. Subcommittee recommendations are supported by appropriate information and documentation. Currently five subcommittees are functioning as part of the WOG: Operations Subcommittee, Analysis Subcommittee, Technical Specifications subcommittee, the RRG, and the Materials Subcommittee. Refer to Figure 1. Special working groups are sometimes included within subcommittees. The Trip Reduction Assessment Program Working Group is such a working group and reports to the Operations Subcommittee. The WOG membership is well represented on each of the subcommittees and working groups. The responsibilities of the subcommittees are defined as follows:

- Establish technical work to be performed and recommend to Steering Committee and WOG appropriate direction and costs because the expenditures on generic WOG efforts are voted on by the full WOG.

- Maintain records of subcommittee activities, and distribute meeting minutes to all subcommittee and WOG members

- Monitor and approve costs incurred relative to funding authorized.

The charter has a provision for smaller groups of utilities to function under the protection of the full WOG. This provision has been utilized occasionally to the benefit of subgroups of WOG member utilities faced with particular issues to resolve. Examples of these issues include further studies into steam generator tube ruptures, turbine governor valve surveillance, outside-containment mass energy releases, and main steam safety valve discharge capacity.

PROGRAMS COMPLETED BY WESTINGHOUSE OWNERS GROUP

Because the WOG primarily addresses issues that are generic to the member plants, virtually all the money appropriated for programs to date has been spent on three major areas of concern. These are generic analyses, the Emergency Response Guidelines (ERGs) used by the utility to develop plant-specific emergency operating procedures (EOPs), and improvements to plant technical specifications. Table 1 lists the major post-TMI regulatory action items that have been undertaken by the WOG since 1980. Table 2 lists the major issues being worked on by the WOG.

The WOG has generated a large amount of technical information from its various programs. This information is in the form of periodic program reports, WCAPs, and letters. These documents are distributed to utility members through WOG meetings, seminars, and mailings directly to utility representatives. Reports that are developed from each WOG program may contain beneficial information for WOG member plants, especially the training department. The utility training department can access this information through its WOG Representative who receives a copy of all of the documents generated from WOG programs.

The WOG provides generic information which can easily be evaluated by the utility to determine its proper use and implementation in their own plant programs. Training Departments that play a role in this effort can easily assess the material's usefulness in improving personnel performance in the areas of operation, maintenance, engineering, and regulation.

The key to effective utilization of the WOG generated materials is the utility representative to the WOG. This person is the focal point for any communications between the WOG and the utility person needing the information. Evaluation and possible implementation of WOG materials into training programs may result in many unanswered questions. Training personnel should be able to access their WOG utility representative with any questions they may have on the materials. If the representative is unable to answer the questions, it can be referred to the appropriate subcommittee that developed the materials. Many times the question may be answered by direct contact with those who performed the work.

Table 1. List of Some Issues Undertaken by Westinghouse Owners Group Since 1980

Operational Issues

1. Development of Emergency Response Guidelines for implementation into plant specific Emergency Operating Procedures
2. Task analysis of ERGs to identify control room operator tasks for use in Control Room Design Reviews
3. Davis-Besse Incident Evaluation of NUREG findings and assessment of their relevance to WOG plants
4. ERG Training Material Development and Seminars with emphasis on Pressurized Thermal Shock, Steam Generator Tube Rupture, and Loss of Coolant Accidents
5. NRC ERG Seminar to familiarize NRC examiners with ERG format and use
6. Post Accident Sampling for Core Damage Assessment based on radioactive isotopes contained in primary coolant after an accident
7. Detection and Cause of Voiding during RCS Transients and void control as per NUREG-0737

Analysis Issues

1. Relief and Safety Valve Performance Test to verify reseating capability during the relief of steam and water
2. Pressurized Thermal Shock effects of Small Break Loss of Coolant Accident analysis which allowed less restrictions on plant operations
3. Power Operated Relief Valve Failures/Sensitivity Studies which satisfy the NUREG-0737 requirements for PORV failures and testing
4. Auto Trip of Reactor Coolant Pumps during LOCA analysis which indicated that an auto RCP trip is not necessary during LOCA conditions for Westinghouse NSSS

Table 1 (Cont). List of Some Issues Undertaken by Westinghouse Owners Group Since 1980

5. Experimental Verification of RCP Seal Integrity Performance with Loss of All AC Power
6. New SBLOCA Model and Plant Specific Analysis to assure continued safe reactor operation after NRR review as per NUREG-0737

Technical Specifications Issues

1. WOG Technical Specification Optimization Program use probabilistic risk methods to assess and revise as appropriate outage times and surveillance intervals for reactor protection systems and engineering safety features instrumentation systems
2. Anticipated Transient Without Scram (ATWS) Rule which provides a diverse turbine trip from the reactor protection system and auxiliary feedwater start in order to limit pressure rise during an ATWS including defense against diverse SCRAM to address the need for a second reactor trip method
3. Anticipated Transient Without Scram Mitigation System Actuation Circuitry (AMSAC) Design development and submittal to the NRC for review and approval
4. Elimination of Diverse SCRAM Program evaluated the need for a second reactor trip method
5. Reactor Trip Breaker Issues (Maintenance/Qualifications) which quantifies a basis for breaker test/maintenance practices

Materials Issues

1. Pressurized Thermal Shock screening criteria to show that risk of vessel failure is acceptably low with options if criteria exceeded

Table 1 (Cont). List of Some Issues Undertaken by Westinghouse Owners Group Since 1980

2. Irradiation Damage Trend Curve provides greater margin below PTS screening criteria and increases heatup and cooldown margins for plant pressure/temperature curves
3. Reactor Vessel Beltline Materials Database to determine best estimate copper and nickel values for beltline welds
4. WOG Input for NRC NSSS Bolting Concerns, Generic Issue

Table 2. Recent Issues Undertaken or in Progress by the Westinghouse Owners Group

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Operational Issues

1. Davis Besse Evaluation identifies potential issues from the incident in order to enhance the safety and reliability of WOG plants
2. Evaluation of MOV Common Mode Failures During Plant Transients Resulting from Improper Switch Settings in order to ensure that torque switch settings are proper
3. Methodology for Elimination of the Spray Additive Tank in order to simplify plant design, eliminate hardware, reduce maintenance/testing/radiation exposure, and eliminate Technical Specification requirements
4. ERG Maintenance Program systematically obtains, documents, evaluates, and reports on feedback from the ERGs
5. Trip Reduction Assessment Program evaluates plant trips and develops software and hardware modifications that will reduce the frequency of plant trips

Analysis Issues

1. Severe Accident Policy Compliance for Industry Degraded Core (IDCOR) which follows severe accident evaluation methodology and minimizes possible major plant specific studies
2. Dropped Rod Protection System which provides an NRC approved basis and defense for the elimination or relaxation of the negative flux rate trip or turbine runback for plants which rely on those features for dropped rod protection
3. Small Break LOCA (SBLOCA) NUREG 0737 development of SBLOCA code and model to assure continued safe operation per NUREG-0737

Table 2 (Cont). Recent Issues Undertaken or in Progress by the Westinghouse Owners Group

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4. RCP Seal Integrity Program analyses for RCP seal condition after a loss of all electrical power without any RCP seal cooling for WOG plant licensing and safety issues

Technical Specifications Issues

1. Technical Specification Improvement Program which identifies and evaluates problems with Technical Specifications and recommends potential solutions to the NRC
2. Reactor Trip Breaker Maintenance/Surveillance Optimization Programs provided technical information on the RTBs with emphasis on monitoring and surveillance
3. WOG Technical Specification Optimization Program uses probabilistic risk methods to assess and revise as appropriate outage times and surveillance intervals for reactor protection systems and engineering safety features instrumentation systems
4. ATWS Mitigation System Actuation Circuitry (AMSAC) Generic Design Program licensed an AMSAC system approved by the NRC
5. Generic Design of Protection Channel Bypass Circuitry

Materials Issues

1. NSSS Primary Boundary Bolting and Closures Instruction Manual provides torque specifications for bolts/fasteners, lubricants, and bolt materials for WOG plants
2. Irradiation Damage Trend Curve Development
3. Enhancement of Data Base for Irradiated RV Beltline Materials based on surveillance, capsule, and test reactor data
4. Evaluate the Effects of Aging in Cast Stainless Steel on Structural Integrity for pump casings and valve bodies in

Table 2 (Cont). Recent Issues Undertaken or in Progress by the Westinghouse Owners Group

---

order to eliminate inservice inspections and thus reduce man-rem exposures

5. UT Inspection of Main Coolant Loop Welds Program which provides more meaningful inservice inspections on Cast Stainless Steel piping
6. Flux Thimble Blockage Program identifies causes of blockage and provides recommendations to reduce or eliminate it, thus reducing utility maintenance costs
7. Plant Life Extension concentrates on critical plant components evaluation that may prohibit the extension of plant life
8. Component Cooling Water System Replacement Corrosion Inhibitors Evaluation Program which assesses the effectiveness of alternate corrosion inhibitors on system components and the environment, thus eliminating chromate releases

The ERG Development Program is an example of excellent technical materials that included training programs programs by the WOG. After TMI, it was determined that the emergency procedures were grossly inadequate for accidents consisting of multiple failures. The procedures tended to address a single event rather than addressing multiple plant failures. Therefore, the operators were locked into a single event with actions that may or may not have been appropriate for the symptoms in the plant. The actions taken could have even further degraded the accident. Because of this, the WOG approved a program to upgrade the emergency procedures. The program went through many iterations, which ultimately resulted in the Emergency Response Guidelines. The ERGs are symptom based rather than event based; they have the operators take actions based on the most critical plant symptoms. If a steam generator tube rupture has occurred coincident with a steamline break, then the ERGs would first address the symptoms of the steamline break. After the appropriate actions for the steamline break have been taken, actions for the steam generator tube rupture symptoms are taken. The ERGs provide flexibility in handling multiple plant failures in the order of highest priority.

The Emergency Response Guidelines are based on a generic Westinghouse plant. However, it was recognized that the member plants could be separated into two categories; the high-pressure injection plants and the low-pressure injection plants. Generic guidelines were developed for both the generic high-pressure and low-pressure plants.

In order to provide consistency in the writing of the guidelines, a Writers Guide was developed. This Writers Guide provided a rigid set of rules for writing each guideline consistently. A generic Users Guide was also developed so that the guidelines would be used as intended by the developers. Any improper use of a guideline could result in improper responses and further degradation of plant conditions. Therefore, consistency in writing and use of the ERGs was a priority in the ERG Development Program.

With the development of the ERGs, it was recognized that the utility writer for the plant-specific EOPs would have to understand the intent of guidelines and guideline steps in order to adapt the ERGs to their plant. Therefore, extensive background documents were written in order to provide the utility writer with sufficient information to adapt the ERGs to plant-specific EOPs. An extensive amount of analysis was performed for the development of the ERGs since the FSAR did not analyze for multiple events. All this material was incorporated into the background documents.

Generic issues arose as the ERGs were developed. These issues were addressed separately from the background documents. However, the generic issues were referenced in the background documents for any step or steps that may have needed further amplification. The Writers Guide, Users Guide, history of the ERG development, and generic issues were incorporated into one volume, the Executive Volume.

After the ERGs were fully developed, a program called Verification and Validation was implemented. Each guideline was verified to be written properly based on the generic Writers Guideline, and they were also verified to be technically correct. After the verification process, the ERG network was extensively exercised during rigorous scenarios on a plant-specific simulator. These exercises allowed the ERGs to be used in a realistic control room environment by trained operators.

The exercises were carefully evaluated by multi-disciplined teams consisting of operational engineers, licensed operators, human factors engineers, and training personnel. The validation provided an opportunity to assess the usefulness of the ERGs during multiple-accident conditions. It also provided valuable data in determining if the guidelines had met their intent.

Many volumes of material was developed to support the writing of plant-specific EOPs. However, the Procedures Subcommittee (now the Operations Subcommittee) recognized that the focus was mainly on the development and implementation of the ERGs with little thought given to operator training. The ERGs are evolutionary in that they have little resemblance to the event-based Emergency Operating Instructions (EOIs) of the past. The ERGs and Users Guide should be considered new and unique to the operator who has been trained on the EOIs. Most operators are not familiar with a two-column format approach to procedures. Even though the seven volumes of material developed for the writing and implementation of plant-specific EOPs contained information of great value to operating staffs, it was not in a form directly usable in a formal training program. As a result the WOG funded the development of several training courses.

The first training course was developed as part of the Validation Program for the ERGs. The operators involved with the validation received a one-week course that covered the Users Guide and a basic overview of the ERGs. The materials from this course were made available to WOG members as part of the Validation Report.

Other significant WOG training courses were authorized to focus on some other specific issues. The first major training course addressed the Pressurized Thermal Shock (PTS) issue. This training course covered all aspects of PTS, including additional analysis. Two volumes of generic materials were developed specifically to train utility plant personnel. One volume, the Technical Volume, contained technical material for use by the student. Each technical section contained objectives, text to support objectives, vocabulary, pertinent references, and self-assessment questions. The second volume, the Instructor Information Volume, consisted of lesson plans (based on the text material contained in the Technical Volume), information to adapt the materials for plant-specific use, examination bank/key, and information on how to provide PTS training on a simulator. Even if the utility did not have the time or the resources to make the materials plant specific, the generic material could still be effectively used to train plant personnel in the basic principles.

Two other extensive training courses were funded by the WOG for training plant personnel on ERG-related subjects. The SGTR Training Course and LOCA Training Course were developed to support ERG training. Technical information and instructor information volumes were also developed for these training programs along with the addition of a third volume, the Guideline Information Volume. It contained extensive information for training personnel on guidelines pertinent to the training course. The SGTR and LOCA Training Course development programs each authorized a one-week training seminar. These seminars provided utility training personnel with the training materials developed for the programs, explanations of the materials, and the opportunity to question those individuals who developed the programs. It was envisioned that the training personnel who attended the seminar could return to their respective utilities and integrate the materials into their plant specific training programs.

The final ERG program to be implemented was the ERG Maintenance Program. It evolved as a means to document and evaluate important feedback information concerning the ERGs. Any feedback information that is generic in nature and has merit to improve the ERGs is collected and evaluated in detail. Worthwhile information is then systematically returned to the WOG members for possible implementation into their EOPs. The WOG also retains the information which may be used for a future ERG revision. Sources of feedback information can come from any utility source that is associated with the ERGs. For example, the disciplines of engineering, licensing, training, and operations have all been suppliers of feedback on the ERGs. Also, a large amount of feedback material was generated when the Revision 1

ERGs were validated, and more feedback came when plants performed their own plant-specific EOP Validations.

The WOG also supported the ERG Program by sponsoring a seminar for NRC-licensed operator examiners. The NRC seminar provided the NRC examiners with a better understanding of why the ERGs were written in their unique format and how the ERGs are expected to be used. The seminar also provided an opportunity for the examiners to ask questions and clear up any misunderstandings. Simulator demonstrations were also run to show the effectiveness of the ERGs during major plant accidents.

The ERG Development Program is an excellent example of how the WOG has provided utility training departments direct support in preparing their operations staff for EOPs implementation. In return, the training staffs provided important feedback to the WOG on potential problems with the ERGs. This mutually beneficial arrangement can only strengthen the usefulness of the WOG and improve overall plant safety.

RECOMMENDATIONS TO IMPROVE THE BENEFITS OF THE WOG FOR TRAINING

The WOG is very well organized and managed by competent and experienced utility members. However, problems do arise, especially in the area of communications and dissemination of technical information. The WOG membership is international and thus encompasses a wide variety of utilities. Many utilities are unable to send proper representation to the WOG meetings and seminars. Even though all of the important information developed by the WOG is sent to utility representatives, the significance of some of the material may not be fully understood by the utility representative. The receipt of WOG documentation by the utility representative does not mean that it will end up in the possession of the individual or group who can most effectively use it. This problem can be alleviated when the owners group itself specifies or recommends those utility departments or groups who could most benefit from the information. The utility representative could then ensure that the material got to the appropriate group. Greater use of the documentation will generate more beneficial feedback to the WOG whether it be in the form of questions and/or recommendations.

Another area involves utility training department resources and limitations. Since the WOG generates a tremendous amount of technical material, it is difficult for training staffs to filter all the information and integrate it effectively into training courses. This situation can result in vital technical material not being used. The end result is that the utility supports the WOG and yet does not fully utilize the benefits of such an organization.

The importance of personnel training has risen steadily since the TMI accident, especially in the areas of plant operations and maintenance. Utilities have been required by the NRC to upgrade their training programs significantly and to invest in new training resources and facilities. One-time investments of tens of millions of dollars is not unheard of along with annual training operation budgets of millions of dollars. Utilities must now conform with INPO accreditation requirements and seek standards of excellence rather than the minimum requirements. To this end, the WOG can contribute readily for its member utilities. Many training issues are generic in nature. A well-developed set of training documentation for one plant or a generic plant can easily be modified for a specific plant. Highly technical or unusually difficult or unique training requirements can be handled most efficiently and cost effectively by a joint organization. This situation could be improved if utility training departments established a special organization that is focused on training within the WOG structure. It is suggested that a Training Advisory Group (TAG) be chartered to function within the WOG structure. This group would consist of utility training representatives that would continuously review the technical information developed by the WOG and make recommendations as to how the materials could be implemented into utility training programs. The TAG could interface directly with the Steering Committee and indirectly with the individual subcommittees. Any program that may be funded by the WOG could be reviewed by the TAG and recommendations could be provided on the training aspects of the program. These recommendations could include no training necessary, training recommended but developed by the individual utility, or a generic training program developed by the WOG for use in utility training programs (similar to the ERG Training Programs). The TAG could also receive direct input from the utility training staffs on training issues and programs that may help other member utilities. The TAG could evaluate the training program and assess its feasibility for generic use by the WOG and then present its results to the Steering Committee for review. If the Steering Committee determines that the program requested by the TAG is worthwhile, then it would send it to the WOG membership for approval by vote. The TAG could also determine which subcommittee or group could best develop, implement, and monitor the program. It would provide the WOG with training representation and insight for all the WOG funded programs. The actions of TAB would ensure that utility members would receive Subcommittee reports with training recommendations and/or documentation.

CONCLUSIONS

The NSSS Owners Group provide their utility members with shared technical expertise, shared experience, and shared costs. The overall financial savings to each member for the diverse programs funded by the Owners Group is substantial. The Owners Group provides its members with excellent technical materials to improve plant operations, design, maintenance, engineering, and training. This technical information should be used more effectively by individual utility training departments to improve training programs. The effectiveness and credibility of utility training could be further enhanced if training was spotlighted more in Owners Group. A special training group could advise the Owners Group from a training standpoint as to how funded program materials can be better implemented by utility members. It could also recommend generic utility training materials and courses for funding by the Owners Group. The overall result of enhancing training quality within the nuclear industry would be improved plant operations and safety and greater public acceptance of the Nuclear Power Option.

WESTINGHOUSE OWNERS GROUP MEMBERSHIP STRUCTURE

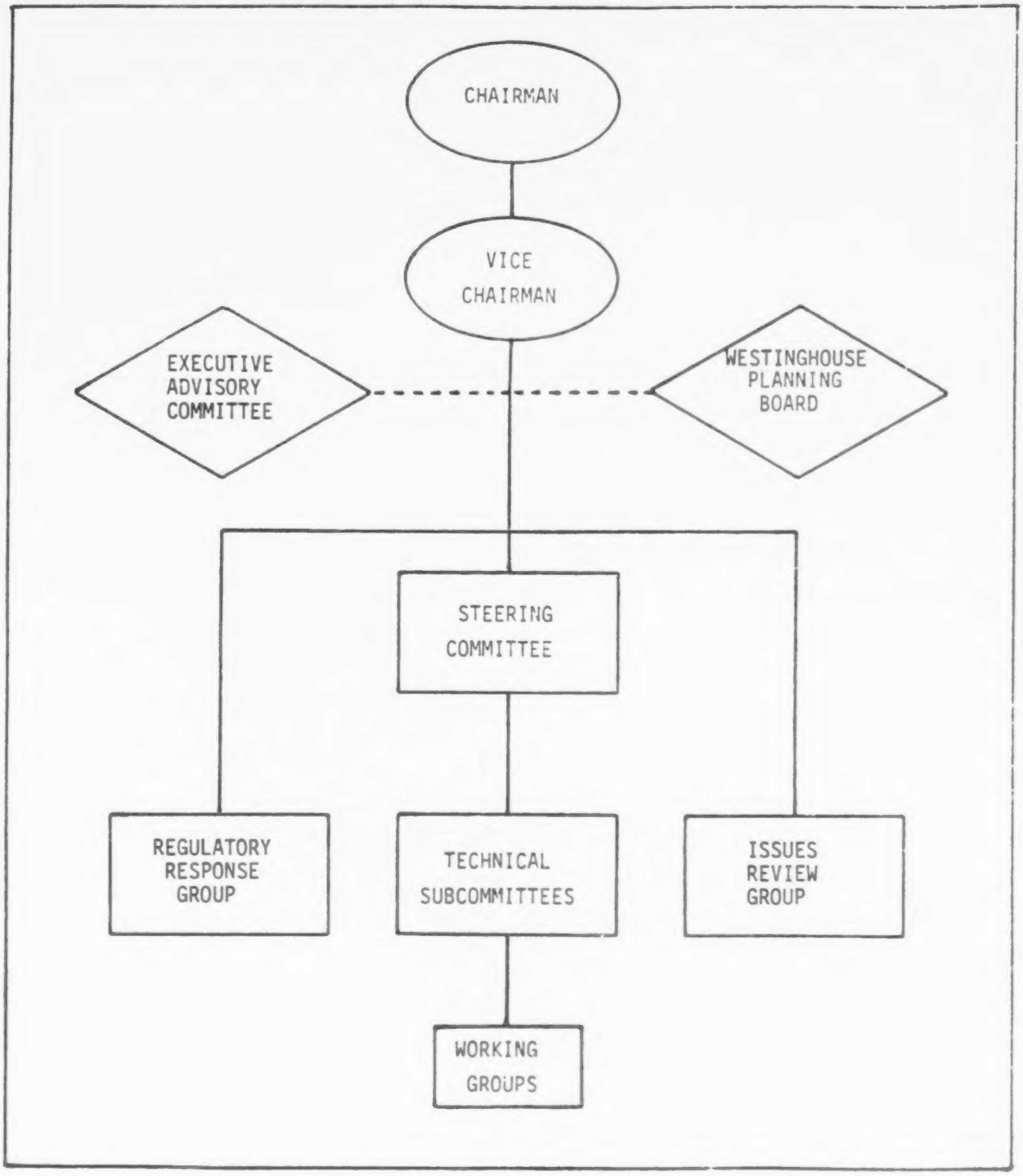
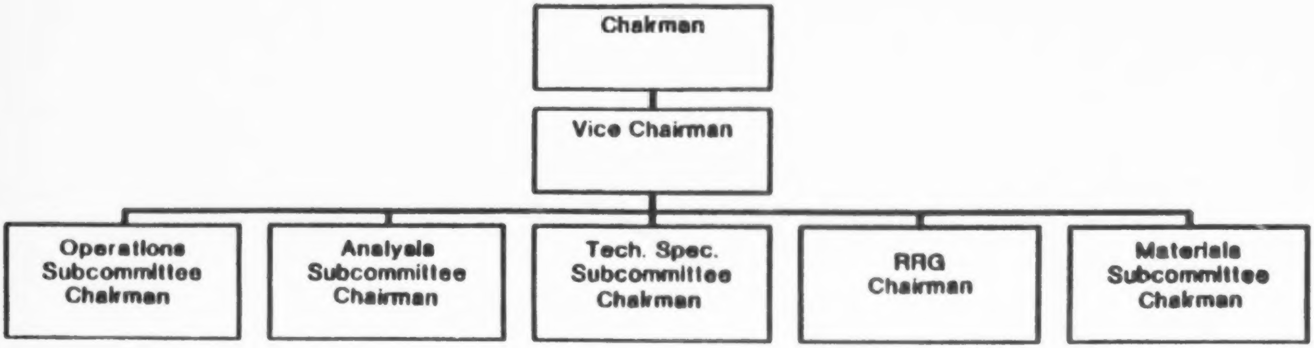

CHAIRMAN
VICE CHAIRMAN
EXECUTIVE ADVISORY COMMITTEE
WESTINGHOUSE PLANNING BOARD
STEERING COMMITTEE
REGULATORY RESPONSE GROUP
TECHNICAL SUBCOMMITTEES
ISSUES REVIEW GROUP
WORKING GROUPS

Fig. 1. Structure of Westinghouse Owners Group

STEERING COMMITTEE STRUCTURE

WOG



Chairman

Vice Chairman

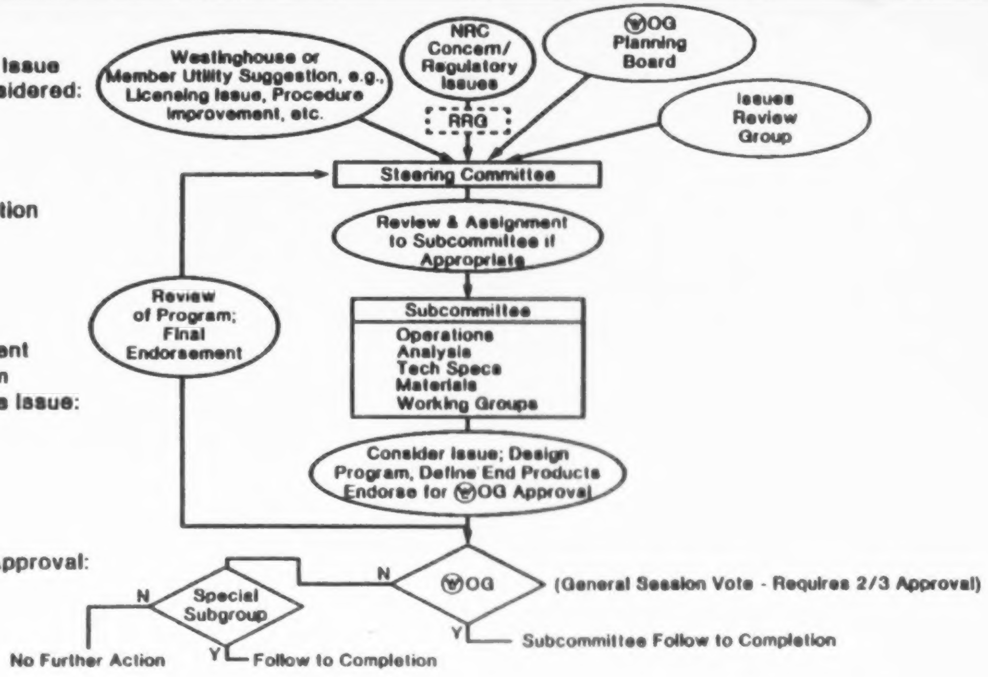
- Operations Subcommittee Chairman
- Analysis Subcommittee Chairman
- Tech. Spec. Subcommittee Chairman
- RRG Chairman
- Materials Subcommittee Chairman

FIGURE 2

MODE OF OPERATION

OG

- **Source of Issue to be Considered:**
- **Consideration of Issue:**
- **Development of Program to Address Issue:**
- **Program Approval:**
- **Closure:**



Westinghouse or Member Utility Suggestion, e.g., Licensing Issue, Procedure Improvement, etc.

NRC Concern/ Regulatory Issues

RRG

OG Planning Board

Issues Review Group

Steering Committee

Review & Assignment to Subcommittee if Appropriate

Subcommittee

Operations
Analysis
Tech Specs
Materials
Working Groups

Consider Issue; Design Program, Define End Products Endorse for OG Approval

Review of Program; Final Endorsement

OG (General Session Vote - Requires 2/3 Approval)

N

Y

Subcommittee Follow to Completion

Special Subgroup

N

No Further Action

Y

Follow to Completion

963 D017187 014

FIGURE 3

NRC INFLUENCES ON NUCLEAR TRAINING

John N. Hannon

ABSTRACT

NRC influences on utility training programs through prescriptive requirements and evaluation of industry self-initiatives are discussed. NRC regulation and industry initiatives are complimentary and in some instances industry initiatives are replacing NRC requirements. Controls and feedback mechanisms designed to enhance positive NRC influences and minimize or eliminate negative influences are discussed. Industry and NRC efforts to reach an acceptable mix between regulatory oversight and self-initiatives by the industry are recognized. Problem areas for continued cooperation to enhance training and minimize conflicting signals to industry are discussed. These areas include:
requalification examination scope and content, depth of training and examination on emergency procedures; improved learning objectives as the basis for training and examination, and severe accident training.

III.A.1.1

PERSONNEL SELECTION AND EMOTIONAL STABILITY CERTIFICATION: ESTABLISHING A FALSE NEGATIVE ERROR RATE WHEN CLINICAL INTERVIEWS ARE DONE "BY EXCEPTION"

Philip E. Berghausen, Jr., Ph.D.

ABSTRACT

The security plans of nuclear plants generally require that all personnel who are to have unescorted access to protected areas or vital islands be screened for emotional instability. Screening typically consists of first administering the MMPI and then conducting a clinical interview. Interviews-by-exception protocols provide for only those employees to be interviewed who have some indications of psychopathology in their MMPI results. A problem arises when the indications are not readily apparent: False negatives are likely to occur, resulting in employees being erroneously granted unescorted access. The present paper describes the development of a predictive equation which permits accurate identification, via analysis of MMPI results, of those employees who are most in need of being interviewed. The predictive equation also permits knowing probable maximum false negative error rates when a given percentage of employees is interviewed.

Emotional stability screening is valuable in helping to ensure reliability on the job. It is also useful for maximizing responsiveness to training. The psychological factors affecting the former are likely to be largely the same as those affecting the latter. The person who is burdened by emotional problems is not likely to benefit as much from training as the person who is not experiencing such a burden.

The security plans of nuclear plants generally require that all personnel who are to have unescorted access to protected areas or vital islands be screened for emotional instability. In virtually all instances, the screening involves the administration of one or more psychological tests, usually including the Minnesota Multiphasic Personality Inventory (MMPI)--a 566-item true-false inventory designed to detect serious psychopathology. At some plants, all employees receive a clinical interview, typically conducted by a psychologist, after they have taken the MMPI and results have been reviewed. At other plants, only those employees with "dirty" MMPI's (ones with some indications of possible psychopathology) are interviewed. This latter protocol is referred to as "interviews by exception." It is the protocol specified in Revision 8 of NUMARC's _Industry Guidelines for Nuclear Power Plant Access Authorization Programs._[1]

Interviewing all employees, regardless of MMPI results, is the most desirable protocol, as the author has argued elsewhere.[2] It is the most consistent with learned opinion in the field of psychology and with the known limitations of psychological tests. Ethical problems may exist when significant decisions are made solely on the basis of the results from a single test. (There is some disagreement on this issue among professionals in the field, and there is evidence that what constitutes an acceptable standard of care is changing.) Employee objections to the screening generally are fewer when everyone is interviewed: No one is singled out as "marginal," the results of an admittedly imperfect test are de-emphasized, and there is an opportunity to get some feedback regarding the test results.

Perhaps most important of all is the empirical evidence derived from actual experience with nuclear plants which demonstrates clearly the potential for error that exists when interviews are omitted.

Behaviordyne Psychological Corporation, which provides emotional instability screening services to the nuclear industry, studied the results obtained from approximately 19,000 employees screened over almost a 10-year period. All employees who were screened were interviewed--not only those with dirty MMPI's. It found that 38% of all employees whom it failed to certify for unescorted access (i.e., 38% of all "noncertifications") had MMPI results devoid of clear indications of the presence of psychopathology. In testing jargon, these were "false negatives." Had these persons been screened by an interviews-by-exception program, many of them (unwisely) probably would have been granted unescorted access to nuclear plants. (Ironically, although the program to screen for emotional instability was designed to protect property and the safety of co-workers and the surrounding community, interviewing by exception would appear to emphasize protection of the rights of an individual employee to the relative exclusion of the other protections that it was created to provide.)

If an interviews-by-exception protocol is implemented, it becomes extremely important to identify accurately, via psychological testing, whom to interview: Anyone who is not interviewed will be given unescorted access without any sort of further review. Behaviordyne decided to see whether it could develop a predictive equation, which, when applied to MMPI data, could assure that all persons who should be interviewed would be, that persons with significant psychopathology would not go undetected by the MMPI, and that false negatives would be reduced to an acceptably low (and known) level.

Fortunately, Behaviordyne had a very desirable pool of data with which to work. Not only was it large (19,000 cases), it was diverse. It included data from employees in a variety of professional/managerial, skilled, and unskilled jobs working at nuclear plants across the country. It included a wide age range (teenagers through those in their 70's) and spanned almost a decade. Most importantly, there was interview data on every person who had completed screening, including those with clean MMPI results--thus permitting study of potential false negatives.

The protocol by which all of these employees were screened was as follows: Each employee was administered the MMPI. The MMPI results were read and interpreted by a licensed psychologist. If the results were clean, the employee was granted an "interim certification," which permitted unescorted access for up to 90 days. If the results were dirty, the employee was given an "interim noncertification," which did not permit unescorted access. Regardless of test outcome, the employee was interviewed, typically within several days to several weeks of the test administration, by a psychologist who sought to ascertain whether the employee met N.R.C.-specified criteria for emotional instability or behavioral unreliability: argumentative hostility toward authority, irresponsibility, defensive incompetence, adverse reaction to stress, and emotional and personal inadaptability.[3] If he or she appeared to meet one or more of these criteria, a noncertification would result--but only if there was concurrence by another psychologist--and unescorted access would be denied. If he or she did not appear to meet any of these criteria (or if there was no concurrence from a second psychologist), certification resulted: The employee was granted unescorted access. (Unlike the interim certification, this certification subsequent to the interview carried no expiration date.) It was possible (indeed, probable), as the data below indicate, for an employee who had received an interim noncertification to receive a certification upon being interviewed. (A person can have psychological problems that pose no risk to a nuclear plant.) Likewise, it was possible (though relatively rare) for an employee who had received an interim certification to lose this certification, as a result of interview findings, and receive a noncertification.

A summary of the results of the screenings is as follows:

--1% of all employees received noncertifications

--78% of all employees received certifications

--21% failed to complete the screening process (were laid off, terminated for cause, eliminated themselves from further consideration because they had received an interim noncertification, became ill, etc.)

--12% of those who failed to complete the screening process had received interim noncertifications

--12% of all employees received interim noncertifications

--88% of all employees received interim certifications

--38% of all employees receiving noncertifications had clean MMPI's (i.e., they had received interim certifications)

--62% of all employees receiving noncertifications had dirty MMPI's (i.e., they had received interim noncertifications)

--6% of all employees who had received interim noncertifications and completed screening received noncertifications

--0.6% of all employees who had received interim certifications and completed screening received noncertifications

--94% of all employees who had received interim noncertifications and completed screening were certified

--99% of all employees who had received interim certifications and completed screening were certified

Included in the present data pool used to create a predictive equation were the MMPI records of all 233 employees who had received noncertifications. An approximately equal number of MMPI records of employees who had received certifications were selected essentially randomly, taking care to see that all years and plant sites were represented in proportion to their representation in the total data pool. These latter MMPI records included those that had elicited interim noncertifications as well as those that had elicited interim certifications. Excluded were the records of employees who had not completed the screening process.

The criterion variable was the clinicians' decisions regarding (final) certification or noncertification (i.e., the decision which followed the interview). Although the accuracy of clinician interview judgments, and their appropriateness for use as a criterion variable, has come under much attack over the years, there is considerable evidence in defense of their accuracy when the decisions made are global ones (as they are in making certification/noncertification decisions).[4] Several studies have demonstrated empirically that interviews in conjunction with psychological testing contribute to the overall accuracy of the decisions which result.[5,6] In addition, in the present study, all decisions leading to noncertifications were confirmed (although not blindly) by a second psychologist. Further reason to believe in the accuracy of clinician judgments is that, to the author's knowledge, employees who have received certifications have never been linked to sabotage in any nuclear plants. The most serious transgressions have been limited to illicit drug sales and/or use. (From a methodological point of view, the best validation of clinician decisions would come from granting unescorted access to all employees--both those who had received certifications and those who had received noncertifications--and waiting to see what problems arose. Obviously the potential costs of such an approach, not to speak of the ethics, are totally unacceptable.)

The MMPI responses of those employees who had received certifications after being interviewed were compared to the MMPI responses of those employees who had received noncertifications. The data were analyzed using multiple discriminant function analysis, a technique generally more powerful than multiple regression analysis. On the first pass, only existing MMPI scales (a scale is a group of items which measure a common construct) and indices (an index usually is a score that results from a combination of scales) were used as predictor variables. In order of predictive strength, the nine with the greatest loadings were: Social Maturity (index), Addiction Band (index), Meehl-Dahlstrom Rules (index), ACG Codes (index), Psychotic Point Count (index), Hysteria Score (index), Responsibility Average (index), MaK (K-corrected Minnesota standard score on scale 9, the Hypomania Scale), and Alcohol Band (index).

It should be noted that only one of these variables, MaK, appears on the original 10-clinical-scale version of the MMPI. (Scales 4 and 6, Psychopathic Deviate and Paranoia, both among the 10 original scales, did manifest some predictive power on their own but not in conjunction with the other 9 predictor variables.) Thus, MMPI scoring systems which yield only the 10 original clinical scales are inadequate for ascertaining accurately which employees should be interviewed.

Using these 9 variables in a predictive equation yielded an accuracy rate of 78%; i.e., 78% of all employees were correctly classified by the equation. A second pass through the data was made to see whether this accuracy rate could be improved upon by using individual MMPI item responses, as well as scales and indices, as predictor variables. Forty-four variables with significant loadings were identified, most of them being individual items. Using these variables in a predictive equation, a accuracy rate of 87.5% was obtained. Cross validation using a jack-knife technique resulted in only minimal shrinkage: The accuracy rate obtained was 85.3%. Present indications are that 30 percent of employees will need to be interviewed in an interviews-by-exception program which uses the cut-offs that yielded this accuracy rate.

The predictive equation will have differing accuracy rates and types of errors (i.e., the relative proportions of false negatives and false positives will change) when different cut-offs are used and when different percentages of employees are interviewed.

Client companies, both utilities and vendors, will be able make informed cost/benefit analyses by using this predictive equation. They will be able to know the maximum number of false negatives likely to result if a predetermined percentage of employees is interviewed. Conversely, if they decide upon an acceptable maximum number of false negatives, they will be able to know the percentage of employees who will have to be interviewed to assure that this maximum is not exceeded.

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APPLICATION OF HUMAN FACTORS DESIGN REVIEW PRINCIPLES AND DATA TO TRAINING

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ABSTRACT

Detailed control room design reviews have been conducted at nuclear power plants to evaluate human factors considerations in the control room. Human factors is a discipline dedicated to improving system design from the operations perspective. The human factors principles considered during the design reviews are also applicable to training. In addition, much of the data generated during the design reviews can be used by training personnel in the development of lesson plans and in classroom or simulator presentations.

A major human factors initiative in response to the Three Mile Island incident has been the performance of detailed control room design reviews (DCRDRs) in nuclear power plants. The U.S. Nuclear Regulatory Commission required that DCRDRs be conducted and published "Guidelines for Control Room Design Reviews" (NUREG-0700). The purpose of the DCRDRs was to review and evaluate control room design from a human factors point of view. The objective was to improve the control room from the operator's perspective. Most nuclear power plants, to our knowledge, have completed DCRDRs at this time. Many of the plants are in the process of implementing control room modifications based on the results of the DCRDR. Also, currently, the focus of human factors attention has expanded from control room design to encompass control room procedures, and from the control room to other work areas in the plant.

Human factors is a discipline dedicated to improving system design from the user's perspective. During the design process, decisions are sometimes made without the user in mind, or without giving due consideration to the user's experience, work conditions, and task demands. As an example, controls may be arranged without consideration of their use. A classic example involves an aircraft cockpit design in which the seat ejection and seat adjustment levers were inadvertently swapped. This design change obviously interferred with the pilots expectations for the lever location based on their previous experience. Even if the pilots could have been retrained to use the correct lever for its intended function, behavior under stressful work conditions often reverts to previously learned responses that have been practiced extensively in one's past experience. Consideration of the users expectations during design, or system modification, can usually eliminate this type of poor design decision.

Other types of human factors problems result when designers have not considered human capabilities and limitations. Humans have remarkable mental capabilities, but we also have our limitations. Operators can remember impressive amounts of technical knowledge, but short-term memory should not be overloaded. For example, requirements for an operator to make complex mathematical calculations in his or her head is usually unnecessary and will often result in errors because of the difficulty of performing complex math mentally. A human factors recommendation might be to provide a table or other written aid to assist the operator in performing calculations. Then, the operator's memory can be focused on the plant situation rather than on mental math.

Humans have physical capabilities and limitations as well. At some plants, we have found requirements for control manipulations that were uncomfortable, if not impossible. For example, small pushbuttons that must be depressed for a long period of time. In this case, some operators' fingers were too large to depress the button. The operators that could push the button, reported that their fingers got uncomfortably sore holding the button down for the period of time required. Once again, the user was not considered sufficiently during selection of the controls.

The purpose of this paper is to review the human factors principles considered and data generated during DCRDRs, and discuss the potential applications of the principles and data to training. Seven major DCRDR activities will be discussed: (1) system function review and task analysis, (2) operating experience review, (3) control room inventory, (4) control room survey, (5) human engineering discrepancy (HED) documentation, (6) evaluation of proposed design changes, and (7) human factors plan for future design modifications.

SYSTEM FUNCTION REVIEW AND TASK ANALYSIS

During the system function review and task analysis portion of the DCRDR, the functions of plant systems were reviewed, operator tasks necessary to support system functions were documented, and information and control requirements needed by operations personnel to perform the tasks were defined. Documentation generated during the system function review and task analysis can be useful to training instructors as a source for "big picture" information about system functions and interrelationships, and the operator's roles in plant operation. The delineation of operator tasks could be used to identify systems operated during emergency tasks, and critical tasks performed during plant emergencies. Both these applications may be useful in developing or sequencing lesson plans to support emergency operating procedures training. Further, the task analysis can form the foundation for, or serve as a cross check of, the job analysis performed for training purposes.

OPERATING EXPERIENCE REVIEW

The operating experience review (OER) portion of the DCRDR involved gathering historical information on control room operations with the focus on problems that involved human factors considerations (primarily at the operator-machine interface). Sources of information such as licensee event reports were reviewed. In addition, operations personnel completed questionnaires and were interviewed to provide a source of historical information the operators could contribute based on their experiences. The OER generated examples and case studies that can be used in training. For example, at one plant, an event report stated that operators were unaware of the reason for a main feedwater pump trip which subsequently resulted in a reactor trip. DCRDR recommendations included annuciator and procedural changes. Until the problem is remedied, this type of example would be a good case study to be covered in training.

Further, LERs or other plant incident reports may have attributed the cause of the problem to operator errors as a result of training or performance. In fact, human factors design problems might have led to the error. When the LER or other report was written, the author may not have been familiar with human factors design problems that could have contributed to the incident. The best trained, most competent operators will still commit errors if the panels, instruments, or controls are very poorly designed for human operation.

CONTROL ROOM INVENTORY

The control room inventory was developed to provide DCRDR team members with a database of control room instrumentation and controls (I&C) against which to compare information and control requirements generated during the task analysis (this process was referred to as "verification"). The inventory can provide a unique source of information on characteristics of plant I&C. For example, trainees may have questions about the range, scale, or multiplier for a meter, or about the functional detentes or range on a controller. This information may or may not be obvious when observing the panels. In any case, the information may not be readily available at a training center.

CONTROL ROOM SURVEY

The control room survey portion of the DCRDR involved the use of checklists and other data collection forms to evaluate the control room against human factors guidelines for: workspace, communications, annunciators, controls, displays, labels, computers, and panel layout.

Much of the information collected during the survey was independent of any particular operating sequence or scenario. For example, if one pair of indicator lights was found to have the red and green lens covers swapped incorrectly, an HED would be recorded regardless of the operational context in which the operators use the lights. At a later stage of the DCRDR, walkthroughs were conducted in the simulator, control room, or at a mock-up. These walkthroughs provided an opportunity for DCRDR team members to record human factors problems in a dynamic, operational context (this was referred to as "validation"). Some control room survey items were further clarified or found during the walkthroughs.

The results of the control room survey include documentation of obvious and non-obvious design principles used during initial board design, or to be used during control room upgrades. Principles such as arrangements of controls and displays based on function, criticality, sequence of use, or frequency of use will be of interest to training instructors. These principles can be used to provide an organizational scheme for the instructor to use in presenting training material. For example, if a panel arrangement of I&C is laid out to be consistent with the system function (using a mimic or other location cues), an instructor may want to discuss the logic behind the control panel layout for the system when he or she is teaching the system.

An additional, related benefit of using the human factors principles is that it provides the operators with a mnenomic, i.e., memory aid, to use in remembering the logic of panel layouts. With the design principle as a memory aid, the operator may find it easier to locate I&C or remember the function, criticality or sequence of the operation.

Other human factors design conventions for location, color, size, or shape coding may not be readily apparent to the new trainee.

HUMAN ENGINEERING DISCREPANCIES

Deviations from human factors principles that were found during the DCRDR activities were documented on human engineering discrepancy (HED) forms. The HEDs that will result in changes to the control room include a justification for the modification that can be used to justify to operations trainees or requalifi-cation crews the basis for changes to the control room. HEDs for which no design change was recommended also have a justification which the experienced operators may be especially interested in since they themselves may have suggested the change. At one plant, for example, operators recommended major changes to the annunciator system. When the utility instrumentation and control personnel found that at that point in time, several years ago, no vendor could supply the necessary hardware, this was explained to the operations personnel. Fortunately, two innovative individuals at this plant configured a computerized aid as a short-term solution to the problem. The utility management supported the aid enthusiastically. If the developers of the computer aid had not been given feedback about the unavailability of vendor hardware, they might have attributed the lack of change in the annunciator system to a lack of support by management. Then, they might not have been motivated to create the solution that they did.

Finally, "fixes" to some of the HEDs involve training. If a discrepancy involves a low probability of error and low safety consequences, no design change may be warranted. In these cases, and selected other instances, training may be invoked as a solution to poor design. The rationale is that alerting operators to design flaws will increase their attention to the problem so they can compensate for the human factors problem. One problem with this is the effect of stress that was mentioned early in this paper. In stressful situations, the operators may be distracted by plant events and forget to compensate for the poor human factors design.

EVALUATION OF PROPOSED CHANGES AND IMPACT ON OPERATOR PERFORMANCE

Evaluation of proposed design changes may be accomplished at the simulator or at a photographic (or CAD drawing) mock-up. Operators in training may be asked to provide comments regarding the proposed changes. They should be encouraged to give feedback on the dynamic operational implications of the change. An instructor may want to observe walkthroughs on the simulator or mock-up to assess the positive or negative transfer that may occur after the change is made. Positive transfer refers to improvements in operator performance in a new situation based on a previously learned situation. For example, assume an operator worked at a nuclear plant that had a good panel layout from a human factors perspective, and then went to work for another plant at which the same panel was laid out poorly. If the plant at which the operator now works changes the poorly-designed panel to ressemble the good layout at the former plant, the operator would be expected to perform well on the panel. This is an example of positive transfer. Negative transfer refers to the opposite situation in which the old way of performing a task interferes with the new. For example, if an operator has worked at one plant for years and has learned to work with a poor panel layout, if the panel layout is improved, one might expect at least an initial performance decrement. This operator would be exhibiting negative transfer because the old way of interacting with the panel might interfere with the new way. DCRDR team members were tasked with the responsibility of evaluating the potential for negative transfer of corrections made to HEDs in the control room. For some HEDs, a trade-off was made between the advantage of any given improvement against the disadvantage of negative transfer. Fortunately, for most corrections, HEDs improvements will be clearly advantageous. For example, clarifying nameplate label nomenclature or reducing high control room noise levels would be expected to improve performance in most cases, or at least not worsen it.

ONGOING HUMAN FACTORS PLAN

A final product of the DCRDR is a plan for an ongoing human factors program so that design changes made in the future take into consideration the human factors guidelines applied as the result of, or before, the DCRDR. The plan includes plant-specific human factors principles to be used by design engineers (and human factors engineers for major design changes). Trainees should be encouraged to provide input regarding positive and negative design examples to be incorporated in the plan.

SUMMARY

In summary, this paper has provided an overview of the information generated during DCRDRs that can be useful to training instructors and instructional materials development personnel. Information related to the human factors review can be of instructional value in the content portion of lesson plans, for example, to provide the "big picture" of operator functions and tasks. In addition, the human factors guidelines used during the DCRDR, such as arrangement of I&C based on criticality or frequency of use, can provide organizational schemes for presentation of information in lesson plans. Finally, instructors with knowledge of the DCRDR can answer trainee questions such as "What is the rationale behind control room panel I&C arrangements?", "Why did the control room change, that I recommended, not get implemented?", or "Why did the control room change?"

THE EXPANDING ROLE OF OPERATIONS TRAINING

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ABSTRACT

The number of licensed nuclear power plants producing commercial electricity is climbing. Attitudes and skills successfully applied to developing the industry are less successfully applied to managing plants in a steady-state mode of operations. Fine-tuning the complex relationships between people and technology is a challenge that requires a fresh perspective.

An increasing number of industry guidelines indicate that effective teamwork, communication, leadership, and diagnostic skills are aspects of human performance requiring attention. A total system view is suggested as a framework to integrate these training needs with the existing base of technical instruction. The total system perspective balances the needs of people and the needs of the physical plant against the unifying objective of profitable, steady-state operations. This perspective favors a leadership role for the training function.

INTRODUCTION

The nuclear power industry has put together systems of incredible magnitude and sophistication. Not only are nuclear generating stations technically and mechanically complex, they are individualistic and fickle. Each plant contains elements of diversity and unpredictability that exceed the automated system's capability to sustain and correct itself. Human intervention is required when the limits of these capabilities are reached.

We need to understand and manage the complex network of relationships between people and the automated technology they have built. The relationship between people and machines in nuclear power plants is one of tension and rigorous performance pressure. The challenge for the industry is to reconcile these conflicts and learn to work effectively in an environment that is saturated with technology.

CHANGING MODES OF OPERATION REQUIRE NEW PERSPECTIVES

As we shift our focus from start-up activities to sustaining operations, certain conditions and problems emerge. The technical skills, attitudes, and models that we apply successfully to building an industry are not automatically transferable to the challenge of stabilizing an industry.

The Dynamics of Industry Start-up

As contributors in the start-up phase, people are encouraged to be technically resourceful, innovative, and driven toward the accomplishment of specific milestones. During start-up, the challenges are visible. Our efforts are continually reinforced by the material evidence of progress. Individuals closely identify their work efforts with tangible results and are motivated by the prospect of finishing things.

Shifting To Steady-State Operations

The elusive challenge of generating a favorable return on assets emphasizes different skills, attitudes and operating principles. The emphasis shifts from putting pieces in place to getting the pieces to work together, smoothly and profitably.

In the sustaining mode of operations, retention of staff and human motivation are compelling issues. The quality of the work environment gains importance as the intensity of start-up fades. Constant pressure to attain a favorable return on assets often reinforces reactive and authoritarian management styles. These styles alienate the more independent, creative thinkers, and bring a "we/they" attitude into the work environment. These conditions increase our sense of isolation and reduce the level of satisfaction we derive from doing our jobs.

"Hours of boredom interrupted by moments of sheer panic." is a phrase used by airline pilots to describe their job. This line gets a nod of agreement from experienced control room operators. The operators and plant staff who are responsible for sustaining the plant have a different relationship with the plant's systems than those who built them. There are frustrations with design decisions that cause unforeseen difficulties and inconveniences. Events occur simultaneously, in patterns that were not predicted. There is the subtle recognition that technology dominates the environment and that the individual is subordinate. The day-to-day visibility of end results and personal identification with a finished product are diminished.

Changing Modes Of Operation Raises Basic Questions

Now that we are here, facing thirty to forty years of steady-state operations, how do we meet the needs of both the machines and the people that make up our plant system? How do we ensure the highest probability of achieving the objective of profitable steady-state operations? What are the most helpful attitudes to balance technology and people in an effective, long-term relationship?

THE PREVAILING ALTERNATIVES:

THE MECHANICAL WORLD VIEW VERSUS THE HUMANISTIC WORLD VIEW

Our attitudes shape the way in which we think and determine the alternatives that are available to us. Our attitudes, considered as a whole, represent our view of the world. When we consider the nuclear facility only from a mechanical view, our approach to problems is mechanical in nature and wears, over time, on human limitations. When we view the plant strictly as a human operation, involving some technology, we overlook concerns that are visible from the mechanical systems viewpoint. How do we balance these attitudes about people and machines, when each represents a view of the world that considers the other to be a liability?

III.A.3.5

The Mechanical World View

The mechanical world view emphasizes the objective reality of the physical plant. The plant, as an intricate arrangement of components and subsystems, demands specific treatment. Precision is essential for the plant to operate in a manner that approximates its design specifications. The terms and conditions of this treatment are described in an ever-growing, ever-changing array of S.O.P.s, industry regulations, and diagnostic procedures. These documents outline the specific roles and responsibilities of all licensed operators and support staff. The implication is, that if people do exactly what is called for, when it is called for, the plant will operate itself.

The viability of the mechanical world view rests on several primary assumptions:

- People will continue to assimilate and recall more procedures and specifications accurately.

- Procedures are current and reflect the actual condition of the plant.

- Properly trained, people will execute the procedure correctly, every time.

- The impact of human personality on performance is neutralized by procedurally scripting roles.

A basic problem with a purely mechanical view is that it discounts human limitations, particularly those that surface over the long term, and assumes that people will respond consistently to change.

Another blind spot in the mechanical view is that it does not allow for the existence of personality. Quirks, kinks, and unforeseen interactions between people and the plant are analyzed in isolation and addressed independently as incidents or events. From the mechanical perspective, we will consider the individual to be a liability, best dealt with by isolating and limiting human intervention.

When we were building the nuclear power industry, the mechanical view helped keep us focused and on track. From the mechanical view, we can stop a system, look at it in still-life, and analyze it. Once a system that includes people is up and running, it is no longer possible to freeze and understand it by examining its parts in isolation. In the sustaining phase of plant operations we need to learn how things work while running at one-hundred percent power.

The Humanistic World View

The humanistic world view holds that the characteristics of the human organism are the most effective model for arranging work and understanding relationships. Machines, once created, are only reliable when actively controlled by responsible people, supported by organizations that reflect human values.

The humanistic view assumes an absolute dependence on the subjective qualities and resources of people. When the plant perturbates and fails to correct itself, when the reactor's unique personality emerges unexpectedly, people are required to diagnose and intervene. The human element is called on to discover the best way to interrupt an undesirable string of events that may lead to equipment damage, down-time, or a situation that jeopardizes public safety.

Much of human factors engineering is based on identifying those intersections of people and machines that cause people to become inefficient, uncomfortable, or unreliable due to the configuration of the plant and its controls. The tendency, when thinking from the humanistic world view, is to find ways to accommodate the machine to the needs of people.

A problem inherent in the humanistic view is the strong evidence that multiple, mechanical accommodations may degrade the performance of technology in unexpected, possibly logarithmic ways. Given the size, complexity, and potential impact of nuclear power plants, it is unwise to look only for ways to adapt the technology to people or to the implicit values of the humanistic world view.

Man versus Machine?

Einstein predicted this difficulty in the relationship between people and technology. He foresaw that traditional approaches to organization and problem solving would not hold up to the long-term task of managing technology and its impact on our lives. As Einstein and others surmised, we need new ways of thinking about ourselves in relation to the technological environment that we have created. A new perspective that balances the mechanical and human aspects of our lives is called for.

While concentrating on the immediate tasks of start-up in the nuclear power industry, we inserted ourselves into a problem. We built plants that require people and technology to operate together, in ways we did not originally anticipate. We are looking for answers from world views that give us an incomplete picture of the situation. We are now challenged to redefine our relationships with other people and machines while we are perched on the edge of change. The reality of the moment is upon us, and whatever we elect to do or not do, will have far reaching consequences.

THE TOTAL SYSTEM VIEW

Within the framework of the total system, everything that happens within the system has an effect on the individual; and conversely, everything the individual does has an effect on the total system. The total system view is the collective identity of all the parts and subsystems of an operation. This collective identity encompasses and supersedes the identity of the individual components and establishes the basis for personal accountability and teamwork.

What is suggested here, is an attitude about relationship that transcends the polarity of the mechanical and humanistic views. It is a mental framework that allows us to develop more comprehensive, responsive relationships with technology and with other people. Through the process of applying the total system view to our work, we learn to balance our human needs with the mechanical needs of the plant.

The development of a total system view cannot be instructed. It is transferred by modeling behavior that is correspondent with the attitude of accountability. The total system view is sponsored rather than taught. Sponsorship is accomplished by providing personal examples for others to observe and emulate, at the learner's discretion and pace.

The exemplary model emerges from the individual, and the organization, that studies themselves in relation to the system around them. This includes noticing how we feel in different situations; watching how we and others react to pressure, boredom, frustration; identifying behavior that is triggered by human interaction and interaction with the plant; monitoring our communication patterns and tendencies; watching how we respond to conflict, sarcasm, and criticism.

When we become watchful of our daily activities, we see patterns that support or add difficulty in achieving our goals. We notice the source of conflicts. When we are capable looking objectively at what we are doing, we can then ask, "What or who are we doing it for?" This question leads us to compare our personal needs with the needs of the total system. From this comparison we will identify ways to bring our objectives in line with the prevailing objectives of the plant. The alignment of needs and objectives with those of the total system, is the cornerstone to a deeper sense of contribution and job satisfaction.

When we see ourselves as contributors, as belonging to something worthwhile and important, our behavior and communication begin to reflect this perspective. We become a model for others to observe relative to their experience. Our awareness and objective expression of how things are, becomes a catalyst for change and improvement in others.

Meeting Industry Needs

There are an increasing number of industry guidelines that indicate a need to train licensed operators in teamwork, leadership, communication, and diagnostic skills. Many training supervisors accept these guidelines as just another curriculum requirement, another commitment, to be satisfied. Some training professionals believe they have programs in place, but are getting signals that their efforts are insufficient. To others, these guidelines represent an opportunity to experiment with concepts and attitudes that will shape their organization's approach to optimizing total plant performance in the sustaining phase of operations. From the total system view, we see the fulfillment of these guidelines as an opportunity to expand the role and methods of training.

Several utilities are integrating the principles of teamwork, leadership, and communication with their existing approach to training and course design. What they are discovering is a process that emphasizes certain premises: 1. The total system view allows each individual to see how their role impacts others and how others have an effect on them; 2. Awareness of interpersonal strengths and weaknesses helps people adjust to new team assignments more quickly; 3. The attitude of accountability stimulates the acceptance of personal responsibility for learning and improving team performance; 4. Training in listening and communication skills develops empathy and consideration for the needs and objectives of others; 5. Interactive, participant centered training techniques improve retention and critical thinking skills; 6. Experienced operators and supervisors have a "coaching role" in the reinforcement of training and skill development; 7. All operations and support staff require exposure to training that emphasizes consistent approaches to teamwork, communication, and diagnostic skills.

When applied with forethought and preparation, training that reflects these premises yields meaningful results. Examples of these results are: 1. Increasing communication and cooperation between individuals and functional groups; 2. Stimulating objective feedback and a positive focus on performance improvement opportunities; 3. Eliminating duplication of effort; 4. Team commitment to common goals and achievement levels; 5. Resolving conflicts and territorial disputes; 6. Sharpening the sense of personal accountability and job satisfaction; and 7. Clearly identifying strengths and weaknesses with strategies to correct performance.

Applying the total system view to balancing the needs of people and technology goes beyond the classroom and challenges the traditional boundaries between training, operations, and other line-support functions. There is no "cookbook" to improving working relationships between people, between functional departments, or between people and machines. There are premises and techniques that can be worked into existing programs. There are strategies and group techniques that can be applied to shaping relationships. The key, however, is the individual. We cannot be "made to be accountable", or "instructed to think in terms of the total system". No one can force us, procedurally or otherwise, to be empathetic. These traits are awakened in people as they see others exhibit them in their work, communication, team efforts, and in the way they think and solve problems.

The decision to invoke change in our relationships with other people, and the machines we work with, is first a choice to permit change in ourselves. We must look at the quality of our experience and decide whether or not we are satisfied with the way things are. We can then assess our personal convictions about the changes that we believe are necessary. From this awareness we can choose the ways that we will demonstrate our conviction through our actions.

In the nuclear power industry there is a rigorous demand for moment-to-moment awareness of the condition of the total system. There is an increased demand on individuals to give, receive, and apply performance feedback. There is a need to be consistently accurate, timely, and complete in the perception and communication of operations related information. This is the field of opportunity for individuals and organizations that are committed to effective and profitable steady-state operations.

Ideas For Application

The following guidelines are being tested and applied in several nuclear power plants to develop a total system view. These guidelines emphasize strategies that reinforce human learning and adjustment, while economizing available resources.

Developing Teamwork

Teamwork, from the total system view, takes on an added dimension. People agree that there is an absolute necessity for each individual to be knowledgeable and technically competent in their role. Personal accountability, in the context of the total system, requires personal awareness and discipline that reaches beyond our traditional approach to teamwork and role definition. There is an implied willingness to identify with something other than the self, and to be open to others identifying with us, gaining knowledge of our strengths and weaknesses.

To hide a weakness or an error damages the team. Developing teamwork involves the trust and insight to communicate objectively, moment-to-moment, about the condition of the total system as each of us perceives it. If the prevailing culture in an organizational system is punitive, it will suppress the communication of facts. For cooperation to flourish, facts must flow unobstructed, to and from the individuals that need those facts in order to operate.

Most of us have not been trained to recognize that a person is experiencing extreme stress or overload. How do we notice, in ourselves and in others, that the limits of knowledge, endurance, or courage are being reached? People must learn what to look for. What is relevant? What is different in each situation? Developing teamwork, in the total system view, relies on self-awareness and sensitivity to others.

Trust and confidence in the integrity of the team is vital to the accurate assessment of each situation and to mobilizing an appropriate responses. Awareness of the trends and tendencies of the people and the plant, is essential to the early recognition of problems and their cause.

What is the level of teamwork in our facilities today? Do team members actively discuss trends and tendencies? Are difficult decisions held off for the next shift to discover and deal with? Are problems with individuals masked as technical problems? Do we think in terms of the total system, or only within the prescribed limits of our roles?

Activities to develop teamwork include:

- Examining the quality of relationship within and between functional groups. List a set of critical variables based on the output objectives of the total system. Develop team profiles that describe strengths and weakness of each functional unit.

- Involving top-management in processes to describe the impact and nature of counter productive team tendencies. Include individuals at all levels in developing and implementing strategies that correct weaknesses and capitalize on strengths.

- Providing individuals with self development tools to assess their technical skills, interpersonal strengths, and nonproductive tendencies. Provide training, counseling and on-the-job coaching in the areas indicated.

- Encouraging the attitude of accountability for team performance by emphasizing individual visibility and specificity of objectives, personal choice, alignment of personal values to total system objectives, positive reinforcement of successive approximations to the goal.

Improving Communication Skills

Different modes of communication are required for various states of operation. The efficiency of communication is measured in terms of accuracy, timeliness, completeness, and relevance. The effectiveness of communication is measured by comparing the results of communication to the intent. When an individual is monitoring plant functions, they are in a receiving or listening mode. Efficient communication is critical. When a response is indicated, effective communication is critical to ensure that the actions taken correspond directly with what has been asked for.

Training can be designed to focus on the skills of efficient and effective communication. Simulator training provides an excellent opportunity to evaluate and test these skills. The use of video cameras and playback are being applied to this purpose in several facilities.

From the total system view, all communication between the parts of the system are valued. Operators and supervisors are aware that the "source" of communication is often given an extra, judgmental value that reflects the receiver's opinion of that source. This results in the informational content being down-played or over-emphasized, depending on the positive or negative value assigned to the source by the receiver. The receiver is often unaware that they are applying this bias to the information. Source bias results in the degradation of the accuracy and effectiveness of communication. Self-assessment tools that measure response bias in communication can be applied in both formal training and coaching activities. Re-qualification training is an excellent opportunity for operators to explore habits and communication patterns that may be blocking valuable information on the job.

We are often trained in the basic mechanics of communication: who talks to whom, when. We receive little or no training regarding the impact that we, as individuals, have on the communication process. Training that emphasizes process skills and personal awareness of the subtleties and responsibilities of communication is necessary. Technical instructors, trained in these techniques, are able to reinforce positive communication patterns in students in all of their regular course work.

Assessing communication needs and improvements can be accomplished by:

- Identifying the critical modes of operation and the communication requirements for each. Specify the criteria for measuring efficiency and effectiveness. Reinforce these criteria during regular course work and simulator training.

- Providing individuals with "process" training that demonstrates the impact of the individual on the results of communication. Teach instructors, senior operators, and supervisors to coach and reinforce positive communication patterns.

- Providing off-line practice and coaching for plant situations that are known to occur frequently. Skill practice should mirror the individual's actual job experience. Deal specifically with the impact of positive and negative "source" bias, anger, boredom, apathy, and panic. Use video feedback and group discussion techniques to encourage feedback between participants.

- Emphasizing communication efficiency during simulator training. Show that the way in which we request information affects the quality and accuracy of response.

- Including operations supervisors in on-the-job reinforcement and coaching strategies to insure transfer of skills.

Thinking and Diagnostic Skills Training

Research indicates that human intervention in plant events during the first thirty seconds increases the probability that the situation will be worsened, by a factor of one.

Simulator instructors have observed that one of the primary causes of test failure is the tendency to react too quickly; before getting a "big picture". Several operations managers believe that many system trips are caused by people over-operating the plant; not taking time to observe the situation and to think. When an individual is trained to respond to specific indications and annunciators, and is evaluated comparatively on the basis of mean-time-to-response, certain affects are predictable. The individual will be acutely sensitized to perceive information specifically associated with their station, and they will be highly motivated to respond quickly.

These response patterns are a direct reflection of how we train individuals to obtain a license. We teach people "what to do" as opposed to "how to think".

Conversely, when an individual thinks from the total system view, they are thinking as a member of the team. When we teach memorization and test only retention, we are encouraging people to think of themselves in isolation. There is an obvious need to qualify and license people individually, and there is a definite efficiency in traditional modes of instruction. There is also the probability, that the exclusive use of these methods, has a dulling effect on the individual's ability to think globally. It is important to balance instructional methods to stimulate thinking and the ability to visualize what is going on in the plant.

Strategies to help balance the instructional approach and to develop thinking skills are:

- Teaching people how to learn efficiently at the outset of license and certification courses. Instruction in various memory and recall strategies will assist people in acquiring fundamentals faster, and in preparing for applications and simulator training.

- Training instructors in techniques that cause higher levels of integration and association in the learner. Using case problems in conjunction with group process techniques is an effective method of drawing out thinking and communication skills. Having students analyze and interpret site-specific event reports builds confidence and analytical skills.

- Improving methods for evaluating instructor performance in simulator and lab environments. Use student feedback and "round-table" discussions to learn, from the student perspective, how the resources in these environments are being utilized by instructors. Brainstorm ideas for improvement with the students.

- Providing training in visualization technique and the use of mental discipline to overcome emotionality, stress, and inappropriate reflexive responses. Give students problems with simple solutions, under high-stress conditions. Train them to "think through" emotional and physical reactions by practicing perceptual disciplines, objective assessment of the "facts", and "at station" relaxation techniques. Tie to skills of communication efficiency.

- Providing training and reinforcement in the adoption of a rational model for problem solving and trouble shooting. Develop efficiency by using the same model plant wide.

- Providing opportunities in license and re-qualification training to learn and practice approaches to team problem solving and trouble shooting.

Licensed and unlicensed personnel should be introduced to teamwork, communication, and diagnostics skills, using methods that will help them manage their relationships in the work environment. By optimizing the timing, delivery, and reinforcement of certain principles, trainers can inject attitudes of teamwork into existing hot-license classes, re-qualification, and maintenance training.

Principles of teamwork can be included as a standard introduction to System Fundamentals, emphasizing the attitudes of accountability and empathy for the total system. These principles can be successively reinforced in subsequent Fundamentals Modules that teach procedures and mechanical repair skills that are team dependent.

The standard instruction of system diagnostics, trouble shooting, and plant maintenance will be enhanced by the introduction of thinking skills and rational problem solving techniques. All groups that receive specific skills training in diagnosing and correcting plant systems, can be simultaneously exposed to critical thinking skills.

Utilizing the simulator during re-qualification training, senior operators and supervisors should be exposed to coaching skills that can be applied to their regular shift duties. When license candidates are assigned to a unit for O.J.T., the senior staff and supervisors will be using the same techniques that the trainee's simulator instructors will use in the next phase of their license course.

A LEADERSHIP ROLE FOR TRAINING IN STEADY-STATE OPERATIONS

The challenge of providing leadership is not limited to those with management authority. Each functional group can contribute to establishing direction and positive momentum. Training, as a functional discipline, has multiple opportunities to introduce attitudes and values that have a positive influence on total plant operations. Introducing these attitudes requires instructors and training managers to lead by personal example.

Many technical training functions have a skeptical attitude regarding change. Alterations to the core curricula require massive efforts from staffs that are already buried. Most technical training professionals are reluctant to make sweeping changes for fear of "throwing the baby out with the bath water." What is suggested is not a replacement or reconstruction of content, but rather an infusion of the total system view into a base of training that already works. The training function can assume a leadership role in the introduction and reinforcement of concepts that support teamwork, communication, leadership, and diagnostics. These skills and attitudes have a unifying influence, when applied from the total system view.

Challenges

Several challenges need to be met for Training to effectively assume a leadership role:

- Eliminate the territorialism and in-fighting that exists between most training departments.

- Expand the basis for on-going collaboration between training and operations groups by establishing cooperative objectives.

- Identify the improvements needed in instructor skills to effectively model and emulate the attitudes desired in others.

- Align the strategic vision for training with the strategy of operations. Involve operations management and licensed staff in a team approach to planning, curricula design, implementation, evaluation and reinforcement of training systems.

- Apply learning strategies that are participant centered. Teach methods that reduce the learning curve in areas that are memory and recall intensive.

- Integrate process concepts into the established sequence of training for licensed and non-licensed personnel.

- Adopt coaching and facilitation skills that will improve the performance of simulator instructors.

CONCLUSION

Each individual must consider their role and response to integrating the people and technology in their operation. When we adopt the attitude of accountability, our specific role and contribution takes on a broader scope, allowing more personal satisfaction.

As the environment matures, we are swept daily into the unknown.

When we assume accountability, we are motivated to look for ways to improve our performance, our relationships, and our ability to personally affect a positive outcome for the entire operation.

How the nuclear power industry performs over the next thirty to sixty years will have as much or little to do with us as we choose. If you or I stand up and declare, "I am accountable for this industry, the technology, the people, the training, and I will, by my presence and choice, have a positive effect on the outcome!"... Who would argue? Would it make a difference? The choices, as I see them, are to work consciously to improve the odds for success, or to sit on the edge of change and wait.

IMPROVED HUMAN PERFORMANCE THROUGH APPROPRIATE WORK SCHEDULING

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ABSTRACT

The Nuclear Regulatory Commission (NRC) has had a policy, Generic Letter 82-12, on hours of work since 1982. The policy states that licensees should establish controls to prevent situations where fatigue could reduce the ability of operating personnel to perform their duties safely (USNRC 1982). While that policy does give guidance on hours of work and overtime, it does not address periods of longer than 7 days or work schedules other than the routine 8-hour day, 40-hour week. Recognizing that NRC policy could provide broader guidance for shift schedules and hours of overtime work, the Division of Human Factors Safety conducted a project with Pacific Northwest Laboratories (PNL) to help the NRC better understand the human factors principles and issues concerning hours of work so that the NRC could consider updating their policy as necessary.

The results of this project are recommendations for guidelines and limits for periods of 14 days, 28 days, and 1 year to take into account the cumulative effects of fatigue. In addition, routine 12-hour shifts are addressed. This latter type of shift schedule has been widely adopted in the petroleum and chemical industries and several utilities operating nuclear power plants have adopted it as well. Since this is the case, it is important to consider including guidelines for implementing this type of schedule.

This paper discusses the bases for the PNL recommendations which are currently being studied by the NRC.

This project is one example of how human factors specialists can help trainers, workers, and licensees achieve improved human performance by providing rationale for appropriate work schedules.

INTRODUCTION

Since 1982, NRC policy on hours of work in the nuclear power industry has consisted of the guidance in Generic Letter 82-12. While that policy addressed hours of work and overtime, it only dealt with periods of up to 7 days and work schedules of routine 8-hour days and 40-hour weeks. Routine 12-hour shifts were not considered. This latter type of shift schedule has been widely adopted in the petroleum and chemical industries and several utilities operating nuclear power plants have adopted routine 12-hour shifts. While there is nothing in present guidance or regulation against such shifts, neither are there any guidelines for implementing this type of schedule.

Recognizing that NRC policy could provide broader guidance for shift schedules and overtime work, the Division of Human Factors Safety, in conjunction with Pacific Northwest Laboratories (PNL), conducted a project to help the NRC better understand the issues concerning hours of work so that the NRC could consider updating their policy as necessary.

PROJECT TASKS

During the early stages of the project, the PNL project staff produced a critical review of the literature on shift scheduling and overtime. It was originally proposed that the initial phase would be a review and evaluation of the available literature pertaining to shift scheduling and overtime practices in nuclear power plants. It soon became evident that little or no research had been conducted in these plants. The solution was to review research in nonnuclear industries that have similarities to the nuclear power industry. The study included federally regulated industries, the military, and a number of field and laboratory studies conducted on hours of work and performance.

The second major task of the project was to assemble a panel of experts to consider limits on total hours of work. Panel members were nine well-known researchers, medical doctors, physiologists, psychologists, and administrators whose experience spanned the Navy, Air Force, and the Coast Guard, and the commercial airline, railroad, and petro-chemical industries. All the members of the panel were selected because of their professional concerns in the area of fatigue and human performance. During a 2-day workshop, the panel developed suggested limits on total hours of work for both 8-hour and 12-hour daily shift schedules for weekly, biweekly, monthly, and annual work periods.

The final phase of the project was to provide recommendations to the NRC for new or modified guidelines on shift scheduling and hours of work for nuclear power plant personnel who perform safety-related work in nuclear power plants. The recommendations covered four aspects of shift scheduling and hours of work:

(1) limits on hours of work (including overtime)
(2) routine 8-hour/day shift schedules
(3) routine 12-hour/day shift schedules
(4) total number of control room operators at a plant.

SOURCES OF DATA

The primary sources of data that were used as technical bases for the recommendations were:

° field and experimental studies in nonnuclear occupations, i.e., airline pilots, truck drivers, railroad operators, air traffic controllers; laboratory experiments on reading speed, vigilance, mathematical ability; scores on a variety of cognitive tests. Most of these studies were reviewed in the project's first report (Lewis 1985 a).

- the experience and knowledge of the panel of experts assembled as part of this project.

- fatigue indexes that were developed for airline pilots. (A fatigue index is an algorithm that estimates the level of fatigue or performance based on factors that cause fatigue, especially hours of work.)

- interviews with employees in the nuclear industry and in nonnuclear industries.

In general, the recommendations are based on a judgmental evaluation of accumulated evidence from many sources, rather than on a single piece of evidence (Lewis 1985 b). This approach was influenced by the experience of other branches of the federal government that have also studied fatigue.

RECOMMENDATIONS

Hours of Work

The recommendations concerning limits on hours of work were actually built on the limits included in current NRC policy. The difference lies in that the recommendations were designed to take into consideration the cumulative effects of fatigue. Simply put, you may be able to work extraordinarily long hours for a week or even two, but if you continue to do that for a month or two or six, you will begin to feel increasingly fatigued. Consequently, the recommendations on hours of work include guidelines for 14 days, 28 days, and 1 year.

I.A.4.5

Recommended Policy on Hours of Work

Time Period	Plant Manager Approval Required to Exceed These Limits	Utility Must at Least Inform NRC if These Limits are to be Exceeded
1 day	12 (16)*	---
2 days	24	---
7 days	60	72
14 days	112	132
28 days	192	228
1 year	2260	2300

*If an operator is absent, his replacement may work up to 16 hours.

The recommendations in the box in the table above are those included in current policy with the exception of the 12-hour limit in 1 day. Present NRC policy allows an individual to work up to 16 hours in 1 day, excluding shift turnover time. The recommendation for a 12-hour limit in 1 day is based on a number of sources. Numerous reports on nonnuclear industries indicate that fatigue increases after 8 hours and increases rapidly after 12 hours. Both present and recommended limits are less stringent than in other regulated industries, i.e., airline pilots and truckers. It is possible, however, that the difference can be justified because the nuclear industry has more backup safety systems. Experimental research shows performance decrements in a variety of cognitive and psychomotor tasks. For instance, reading speed slows after 4 hours and, after 8 hours, pilots' performance in flight simulators declines, and errors on complex tasks increase. In actual on-the-job situations, after 8 hours, aircraft accidents and occupational injuries increase and drivers take greater risks. Observations of flight crews indicate that after 12 hours, pilots become more irritable, less communicative, take more risks, neglect more factors, and forget more (Lewis, 1985 a).

The bases for the limits on the remaining time period are the recommendations of the expert panel, various fatigue indexes, and limits for other regulated occupations. In addition, a 2-year study by one nuclear utility shows that productivity "drastically decreases" after 72 hours, i.e., 6 consecutive days of 12-hour shifts. If productivity decreases drastically, the rationale for working such long hours decreases drastically along with the quality of the work.

Recommended Guidelines for Routine 8-Hour/Day Schedules

Since the majority of nuclear power plants still maintain routine 8-hour/day schedules, it is important that they be implemented in such a way as to minimize fatigue. For this reason, PNL made recommendations for this type of shift, as follows:

1. The schedule should be limited to a maximum of 7 consecutive days of work.

2. The schedule should not exceed 21 days of work (including training) in any 4-week period.

3. The schedule should include at least 2 consecutive full days off in any period of 9 consecutive days.

4. A series of night shifts should be followed by at least 2 full days of rest.

5. The schedule should rotate forward, not backward.

Once again, the bases for these recommendations are the panel's expertise and a great deal of existing research on fatigue, especially as it relates to rotating shifts. Evidence indicates that fatigue accumulates toward the end of a long series of work days. The 21-day limit in a 4-week period follows the same reasoning as does the recommendation that there be at least 2 consecutive full days off in 9 consecutive days. Two full days in this context means 64 hours, which is the number of hours in a normal weekend. Two full days off are recommended after 6 or 7 consecutive night shifts because this shift disturbs one's circadian rhythms most. (Circadian rhythms are bodily rhythms that oscillate within a period of approximately one day. Not only is there a sleep/wake cycle, but body temperature, gastric secretions, and many other bodily functions have circadian rhythms.) When on the night shift, one works when one would normally sleep. In addition, people have difficulty sleeping during the day, so a sleep deficit occurs. Therefore, a longer rest period is advisable after the night shift to readjust one's circadian rhythms to day work and night sleep, and to make up the sleep deficit. Forward rotation, i.e., days to evenings to night, theoretically allows faster adjustment of circadian rhythms if (1) the worker anticipates the next shift and begins to adjust his sleep/wake cycle before rotation, and (2) the worker maintains the sleep/wake cycle appropriate for work even on days off. There also needs to be sufficient time off between rotations. If these conditions are not met, a forward rotation may fail to reduce fatigue. It should be noted that the benefits of forward rotation are still being debated by researchers. However, a number of operators interviewed stated that they found forward rotation less fatiguing.

III.A.4.8

Recommended Guidelines for Routine 12-Hour/Day Schedules

It is understood that many utilities adopt 12-hour/day schedules when overtime is expected to continue for a period of time. This is not the type of schedule to which these recommendations apply. Routine 12-hour schedules are generally designed so that the work week still averages 40 hours. It also usually entails renegotiation of the basic wage rate so that base pay plus "overtime pay" still yields the same total salary as did the routine 8-hour/day schedule. As previously mentioned, there is nothing in current NRC policy that precludes routine 12-hour shifts; neither are there any guidelines for implementing such schedules. This type of schedule has already been adopted by one utility and other plants are considering it. With this in mind, PNL made the following recommendations:

1. The schedule should contain a maximum of 4 consecutive 12-hour work days.

2. Four consecutive 12-hour work days should be followed by no fewer than 4 days off.

3. The basic 12-hour/day schedule should be "2-on, 2-off," "3-on, 3-off," "4-on, 4-off," or a systematic combination of these such as the "every-other-weekend-off" schedule, which combines "2-on, 2-off" with "3-on, 3-off."

4. The general safety record of the plant should be satisfactory, based on criteria such as those used in NRC's Systematic Assessment of Licensee Performance (SALP) ratings.

5. The plant should have the ability to cover unexpected absences satisfactorily without having any individual work more than 12 hours per day.

6. The round-trip commute times for the operators should not exceed 2-1/2 hours.

The first three recommendations are based on existing 12-hour/day schedules. One nuclear plant adapted a "4-on, 2-off" schedule, but later abandoned it because operators became too fatigued. Although the bulk of evidence collected so far indicates that 12-hour shifts are safe and raise employee morale, they are relatively new and unused compared to 8-hour schedules. Until NRC and the nuclear industry gain more experience with this shift schedule, some consideration certainly needs to be given to the overall safety record of the plant. The fifth recommendation is necessary because you cannot fall back on having someone work a double shift (24 hours) to cover for an unexpected absence. Possible solutions are to maintain people on call or staff each crew with extra operators.

The last recommendation was included because excessive commute time inherently leaves less time for sleep. European researchers include adequate sleep time as a criterion for the acceptability of a 12-hour/day shift schedule.

It should be noted that since the completion of this project, PNL conducted a study of the 12-hour shift schedule at the Fast Flux Text Facility (FFTF) at Hanford, Washington. (The 12-hour schedule used at FFTF was as follows: 4 nights; 3 off; 4 days; 7 off; 3 days; 4 8-hour training days; 3 off; repeat.) The schedule was changed from a routine 8-hour/day shift schedule with the primary objectives of reducing attrition and increasing job satisfaction. Because of a concern that potential fatigue could lead to errors that would jeopardize plant safety, the effect of the 12-hour shift on safety was assessed by comparing the number and severity of off-normal events on the 8- and 12-hour shifts. The result of this analysis indicates that there was no satisfactorily measurable difference between the 8- and 12-hour shifts in either the number or severity of events. Error rates in keeping Technical Specification Compliance Logs was lower on the 12-hour shift. Operators definitely were somewhat more fatigued on the 12-hour shift, but this 1-year trial apparently did not lead to any sacrifice of plant performance or safety (Lewis et al, 1986).

The final aspect of the recommendations dealt with the total number of control room operators at the plant. Although PNL considered recommending that each plant have enough control room operators to staff six shift crews, this idea was rejected on the basis that setting limits on hours of work is a more direct way to deal with overtime and fatigue. A recommendation was made that NRC collect data on the number of control room operators currently on staff at nuclear plants in order to assess the degree to which understaffing may be an underlying cause of overtime in the industry.

Conclusion

Shift work, fatigue, overtime, and performance are hardly new issues. Because we initially found little work in this area done in the nuclear power industry does not mean it is irrelevant to us. In 1981 and 1982, the NRC and PNL held a series of workshops as a mechanism for obtaining feedback from power plant operators. During these workshops, operators expressed concern that fatigue could have safety implications (McGuire, Walsh, and Boegel, 1984). In a subsequent survey carried out as an alternative feedback mechanism, over half the operators surveyed said that overtime work sometimes creates plant safety problems. That survey covered 520 personnel at 26 nuclear power plants (McGuire, Walsh, and Morisseau, 1985).

This study was designed to bring together the best comprehensive human factors knowledge available and use it as a technical basis for whatever changes might be necessary to current NRC policy. These recommendations are still being studied to determine which are manageable or feasible while also taking into consideration the productivity and safety of nuclear installations in the United States.

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THE TRAINING DEPARTMENT'S ROLE IN HUMAN FACTOR ANALYSIS DURING POST-TRIP REVIEWS

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ABSTRACT

"Provide training" is a frequent corrective action specified in a post-trip review report. This corrective action is most often decided upon by technical and operational staff, not training staff, without a detailed analysis of whether training can resolve the immediate problem or enhance employees' future performance. A more specific human factor or performance problem analysis would often reveal that training cannot impact or resolve the concern to avoid future occurrences. This human factor analysis is similar to Thomas Gilbert's "Behavior Engineering Model" (Human Competence, McGraw-Hill, 1978) or Robert Mager's/ Peter Pipe's "Performance Analysis" (Analyzing Performance Problems, Pitman Learning, 1984). At Palo Verde Nuclear Generating Station, training analysts participate in post-trip reviews in order to conduct or provide input to this type of human factor and performance problem analysis. Their goal is to keep "provide training" out of corrective action statements unless training can in fact impact or resolve the problem. The analysts follow a "plant specific" logic diagram to identify human factors and to identify whether changes to the environment or to the person would best resolve the concern.

INTRODUCTION

When a plant trips, analyzing root causes, determining corrective actions, and bringing the plant back on line are paramount concerns to the operating staff. The performance data from systems and components and the reports of actions and observations by operators and support personnel are analyzed to identify areas of concern. Questions are raised as to how these concerns may have served as potential causes or aiding factors in the trip, and research is conducted to prove or disprove that the identified concern is part of the root cause. As this type of review progresses, concerns become findings, and recommendations for corrective action are made. Quite often, part of the corrective action to many findings is to provide training--to place the item in the operators' next requalification cycle, to embed it in initial training lesson plans.

Many of these training recommendations are not appropriate corrective actions. A more specific human factor or performance problem analysis would reveal that training is not the solution to avoid future occurrences. Models of this type of analysis can be found in Robert Mager's/Peter Pipe's "Performance Analysis"[1] or Thomas Gilbert's "Behavior Engineering Model"[2] .

MAGER: PERFORMANCE PROBLEM ANALYSIS

Mager defines a performance problem as an instance where people do not do what they are supposed to do or what some other person wants them to do, and these problems are made evident by statements such as:

> "They don't have the right attitude."
>
> "We need a course to teach people..."
>
> "We've got a training problem because our workers aren't safety conscious."(1, p.1)

Responding to such statements with training will help sometimes: if people do not know how to perform, instruction is likely to help. However, when people have known how to perform at one time or another, teaching or telling them again is not likely to remedy the problem.

If the performance problem really needs to be resolved, the first question to ask in Mager's analysis is whether the non-performance is based on a skill deficiency. In other words, can people do what is expected of them if their lives depend on it? If they cannot do what is expected of them, there is a skill deficiency and further analysis related to the need for training should be pursued. If people could perform in the past, but not now, the analysis should determine if they perform infrequently and need practice or if they perform frequently but need feedback on correct performance. The analysis should also determine if the performance is too complex and results would be better achieved by providing job aids, procedures, greater on-the-job training, or actual work simplification. And if people have never been able to perform as expected, the analysis should show the need for formal training followed by practice and feedback.

In Mager's analysis, if people can do what is expected of them "if their lives depend on it," a skill deficiency does not exist. The performance problem analysis should focus on other human factors as causes of the problem, with four courses generally examined:

1. People don't do what is expected because it is punishing to perform.
2. ...because it is rewarding not to perform.
3. ...because it does not matter if they do or don't perform.
4. ...because there are obstacles to performing. (1, p. 3)

GILBERT: BEHAVIOR ENGINEERING MODEL

The external environment and the person--matrixed against a grid of Information, Instrumentation, and Motivation--are the interacting areas which must be analyzed to solve performance problems using Gilbert's Behavior Engineering Model (Figure 1).

	INFORMATION	INSTRUMENTATION	MOTIVATION
Environmental Supports	**Data**	**Instruments**	**Incentives**
Person's Repertory of Behavior	**Knowledge**	**Capacity**	**Motives**

Figure 1. Behavior Engineering Model (2, pp. 83-88)

Analysis of the Environment/Information cell calls for identifying whether people have the data they need to perform well.* This data includes identification of expected performance, clear guides on how to accomplish performance, identification of standards associated with performance, and relevant and frequent feedback regarding adequacy in meeting standards of performance. Analysis of the Person/Information cell calls for identifying the skills and knowledges people will need to use or implement the data from the environment.

For the Environment/Instrumentation cell, the analysis should identify whether there are adequate and accessible references (procedures and persons), tools, and equipment; correct data with which to work; problem-solving authority; satisfactory work facility; and adequate work design and supervision. For the Person/Instrumentation cell, the analysis should identify whether people have the capacity to perform the actual task; to learn the skills and knowledges needed to perform; and to use the tools, equipment, references and other things available to them in the environment.

Finally, for the Environment/Motivation cell, the analysis should identify whether there are meaningful incentives and rewards for performing as desired--incentives such as recognition, compensation, autonomy, and advancement. Analysis of the Person/Motivation cell would identify whether people have expectations or motivations which are compatible with the available incentives and which would lead them to perform as desired in order to achieve the incentives.

THE TRAINING DEPARTMENT'S ROLE IN HUMAN FACTOR OR PERFORMANCE PROBLEM ANALYSIS DURING POST-TRIP REVIEWS

Given the technical background and orientation of most individuals assigned to post-trip reviews, analysis of the performance problem associated with the trip focuses on Gilbert's Environment/Data and Environment/Instrumentation cells. Procedures are reviewed to determine adequacy and accuracy for guiding performance and equipment/system failures and malfunctions are analyzed for their root cause contribution. Problems with the performance of people are most often assumed to be a "skill deficiency" (Mager) or a "lack of knowledge" (Gilbert).

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*(Discussion of the cells includes Donald H. Bullock's amplification in "Understanding Gilbert's Human Competence."[3])

Many times these assumptions are correct: the person could have performed better as a result of training, practice, feedback, or information--the potential solutions to a skill deficiency. Quite often, however, these assumptions are not well founded, and commitments are made to provide training which is inefficient and ineffective for resolving the problem. Equally often, the Training Department has no involvement in making these commitments and sometimes even has no knowledge that the commitment has been made--only knowledge that it has not been met.

To avoid these inefficient and ineffective commitments for training, the Training Department should have an active role in identifying whether a skill deficiency contributed to the performance problem and should have responsibility for recommending the most effective and efficient method for correcting the skill deficiency if one is found. Mager's "Performance Problem Analysis" and Gilbert's "Behavior Engineering Model" represent appropriate analysis tools. In both Mager's and Gilbert's approach to performance problem analysis, factors which can contribute to a training need are presented first--the analyses determine whether people have the information, skills, knowledge, and practice necessary to perform. If these factors are present or do not account for the performance problem, then the analyses consider other human factors which training cannot affect to any significant degree. This is an important sequence for Training Department personnel to follow, as it provides information and feedback on necessary improvements to training or clearly identifies that training cannot resolve the problem. The need for analysis of other human factors can be identified and, if the Training Department has the cooperation or authorization to examine these factors, the analysis can proceed. If not, a skill deficiency analysis can still be completed without stepping into sensitive areas.

PVNGS EXPERIENCE

At Palo Verde Nuclear Generating Station, training analysts with instructional design and occupational analysis backgrounds participate in post-trip reviews. Every effort is made to have an analyst working with the Duty Shift Technical Advisor at the time technical data has been compiled to describe the events of the trip and rough concerns have been drafted. The training analyst works with the STA to assimilate the actual performance problem; discusses and resolves any obviously misdirected training recommendations or concerns; then researches, analyzes, and resolves any remaining training concerns. This requires close interaction with training instructors and supervisors to ensure an accurate assessment of the problem and appropriate Training Department response.

The training analysts' participation in post-trip reviews was a direct response to the problem of having training commitments made by external organizations without the Training Department's input and without adequate analysis to determine the appropriateness of their commitments. Through participation in trips which occurred as Units 1 and 2 went through power ascension tests and into commercian operation, the analysts and the Training Manager assembled an analysis logic and flowpath for post-trip reviews. Since the goal of participation was to avoid inappropriate commitments, the analysis flowpath began with investigation of human factors other than skills deficiencies as possible contributors to the performance problem. The last factors analyzed were whether the person possessed the skills and knowledges needed to perform and whether the training program adequately presented those skills and knowledges.

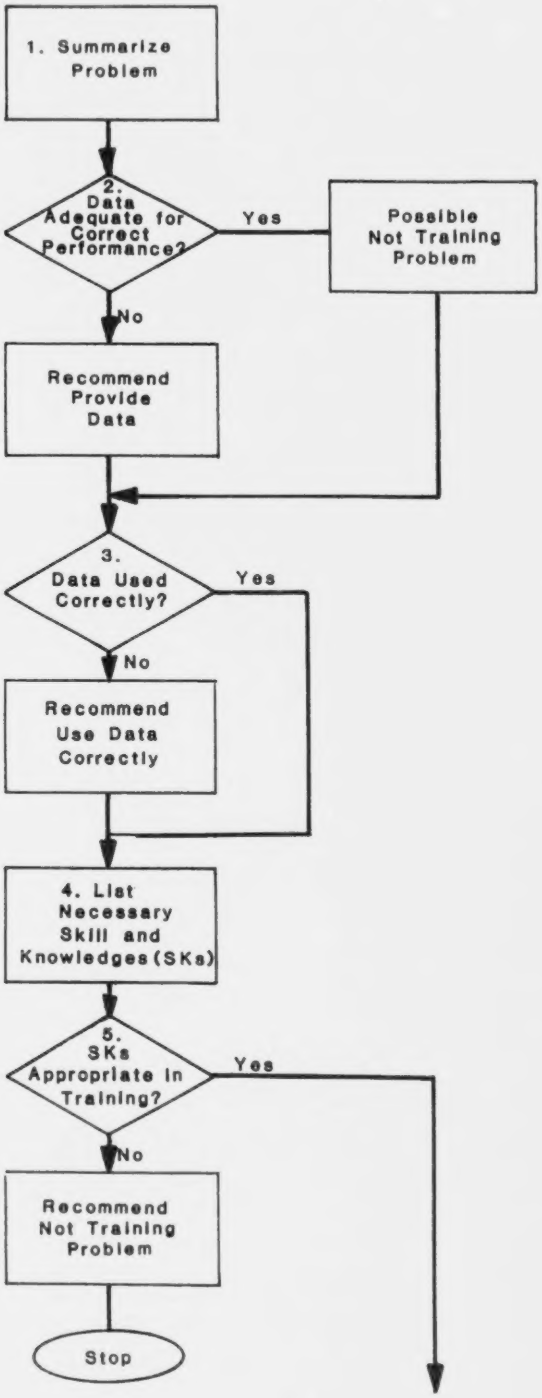
As the training analysts participated in more reviews and as the process became more and more formalized, an internal concern was raised about the appropriateness of investigating non-training human factors, the potential for the analysts' internal and informal records to become part of the official post-trip review, and, as a result of that escalation, the need for having people sign interview notes to document their responses to the analysts' questions.

These concerns led to a reevaluation of the analysis flowpath and a review of human factor and performance problem analysis literature (Mager and Gilbert particularly). The following analysis questionnaire and flowpath were developed to focus clearly on identification of a skill or knowledge deficiency and the need for training to correct that deficiency. This restructuring allows the Training Department to carry out its appropriate role in human factor analysis during post-trip reviews.

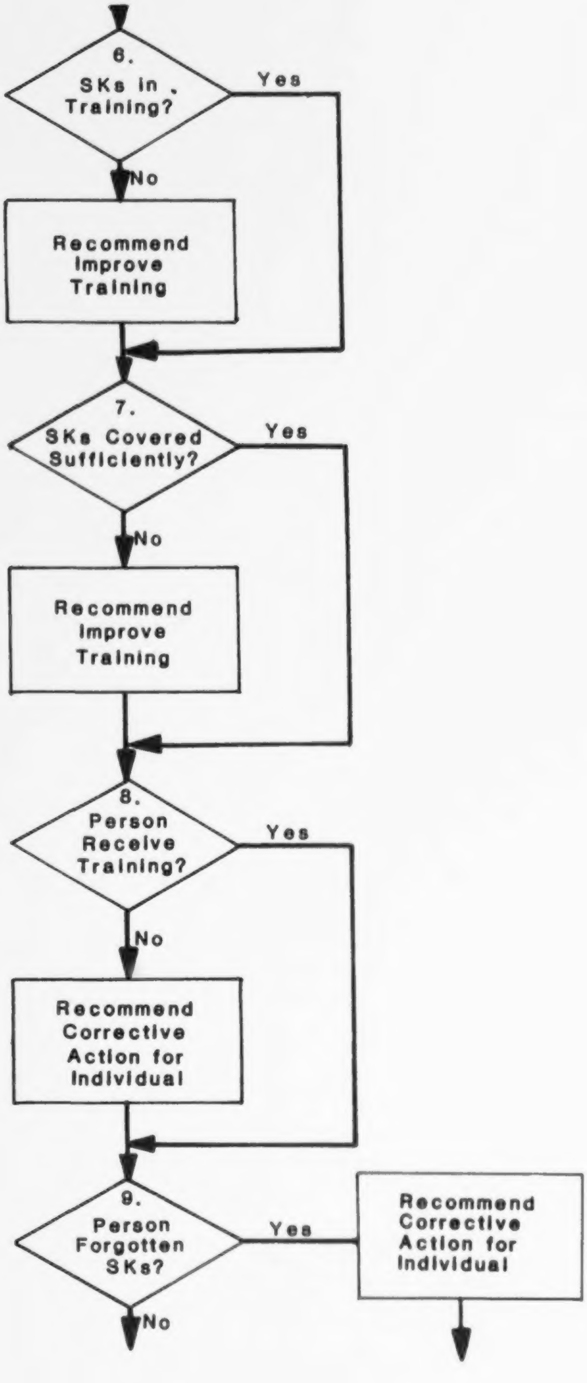
PVNGS TRAINING DEPARTMENT POST-TRIP REVIEW QUESTIONNAIRE

1. Summary of Performance Problem (What was done which should not have been done? What was not done which should have been done?)
2. Was adequate data available to guide performance? (Do procedures or job aids exist to cover performance? Do the procedures or job aids provide correct, clear, and understandable directions on performance? Are standards of performance clearly stated in the procedures or job aids? Have standards of performance been communicated well by other means?)
3. Was the available data used correctly? (Were procedures followed?)
4. Identify the skills and knowledges the person would need in order to use the data or perform the task.
5. Are the skills and knowledges appropriate content for the training program?
6. Have the skills and knowledges been included in the training program? (Verify and list course(s) and lesson plan number(s) for initial and continuing classroom, simulator, and on-the-job training as appropriate. List plant specific task numbers when possible.)
7. Is the coverage of skills and knowledges of sufficient depth to support use of data or performance of the task?
8. Did the person participate in the training/retraining?
9. Has the person forgotten how to use the data or perform the task? (How long has it been since the person participated in training/retraining? Has the person applied the skill or knowledge, used the data, and performed the task since training? Has the person gotten feedback on using the data or performing the task?)
10. Do the responses to questions 8-9 describe
    None/few _____
    Many/most_____
    of the other persons who are also responsible to use the data or perform the task?

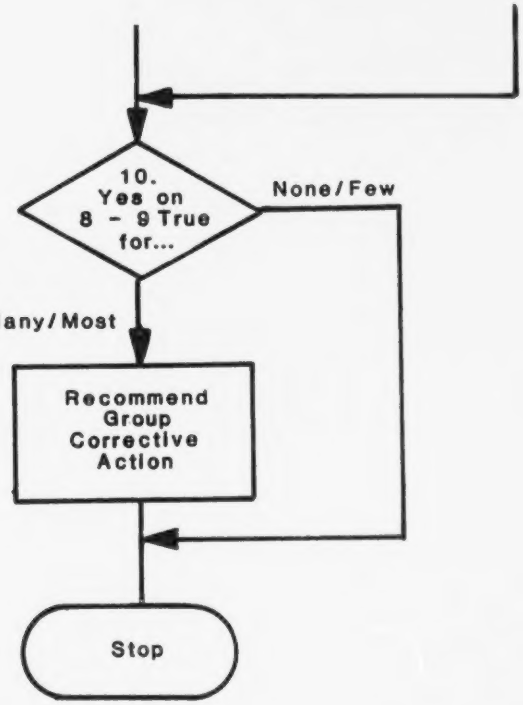
PVNGS TRAINING DEPARTMENT POST-TRIP REVIEW ANALYSIS FLOWPATH


1. Summarize Problem
2. Data Adequate for Correct Performance?
Yes
Possible Not Training Problem
No
Recommend Provide Data
3. Data Used Correctly?
Yes
No
Recommend Use Data Correctly
4. List Necessary Skill and Knowledges (SKs)
5. SKs Appropriate in Training?
Yes
No
Recommend Not Training Problem
Stop

PVNGS TRAINING DEPARTMENT POST-TRIP REVIEW ANALYSIS FLOWPATH
(Continued)


6. SKs in Training?
Yes
No
Recommend Improve Training
7. SKs Covered Sufficiently?
Yes
No
Recommend Improve Training
8. Person Receive Training?
Yes
No
Recommend Corrective Action for Individual
9. Person Forgotten SKs?
Yes
Recommend Corrective Action for Individual
No

PVNGS TRAINING DEPARTMENT POST-TRIP REVIEW ANALYSIS FLOWPATH
(Continued)


10.
Yes on
8 - 9 True
for...
None/Few
Many/Most
Recommend
Group
Corrective
Action
Stop

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HUMAN FACTORS & TRAINING
THE PARTNERSHIP AGREEMENT

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S.T. Fleming
Northeast Utilities
Training Development Supervisor

INTRODUCTION

Four fundamental activities directly affect human performance in operating nuclear power plants:

Control Room Design Reviews (CRDR's)
Operating Procedures
Training Curriculum Materials
Simulator Training

Typically it was believed that multi-disciplined core teams, for each activity, provided an integration of all activities. Representatives of each discipline (CRDR, Engineering, Training, Simulator Project) provided real time inputs during team deliberations. While these inputs affected team decisions, there were no assurances that any functional follow-up would result. Futhermore, no mechanism existed for systematic integration between activities. Now, with a majority of the Control Room Design Reviews complete, plant specific simulators becoming a reality, and the incorporation of Safety Parameter Display System (SPDS) and Symptom Based EOP's; the reality is that these activities require more systematic integration than was previously recognized.

This paper presents an innovative approach for integrating the above four activities using Computer Aided Drafting (CAD) and computerized Data Base Management (DBM) to synergistically optimize human performance.

ACTIVITIES AFFECTING HUMAN PERFORMANCE

With increased awareness regarding the need for improved, human performance, an attempt to more clearly define the substantive interrelationships is being made. Each of the four activities affecting human performance are discussed indicating the interrelationships from our experience and perspective.

Control Room Design Reviews

The primary output of the CRDR is validated control room design improvements which meet good human engineering practices, and have the 'stamp of approval' from the Operations Department. The control panel configuration subsequent to the CRDR has a direct effect on the other three activities. The magnitude of design modifications will dictate the impact. The most obvious case is the simulator. A CRDR project could relocate, and in selected cases, extensively reconfigure a control panel subsequent to the simulator's design freeze. A mechanism to systematically follow the design changes from the actual control panels through to the simulator is essential. Similarly, the design modifications could affect the content and/or sequence of particular procedures. As a minimum, CRDR projects tend to make extensive terminology changes which need to be incorporated into procedures.

Other typical panel improvements involve modifications which would have a direct affect on the content of training materials. A simple example is mimicking; the system line diagrams used in the classroom should correspond to the mimic arrangement on the panel as well as the actual system configuration. As for the procedures, terminology used in the training context should correspond to the operational language used on the control panels and in control room communications.

A mechanism which ensures overall operational/training consistency is necessary.

Operating Procedures

Operating procedures directly impact training curriculum materials and simulator training, and are affected by the CRDR. The upgrading of plant procedures per CRDR operational terminology has been discussed. Further considerations regarding procedure interrelationships are the human factors aspects of the SPDS, the relationship between SPDS design, procedure terminology, and procedure restructuring to support the Symptom based approach. The resultant procedures provide the basis for "proceduralized" operational training, most frequently conducted using the simulator.

Training Curriculum Materials

Training materials are on the 'receiving' end of this process. The above discussed activities dictate changes to the curriculum. Training's role is to facilitate learning. To do this effectively, plant configuration, and procedure content and format are requisite inputs. The essence of the interrelationships is to ensure that training management and staff personnel are provided the necessary information to efficiently upgrade training materials.

Other aspects of training which are integral to the overall issue of human performance, are training feedback and training effectiveness. To close the loop on the overall network, feedback is necessary. This feedback relates to how well operators and teams perform, and how well the training materials prepare operators and teams.

Simulator Training

Simulators have gained broad industry acceptance and are being introduced into utility training programs. To this end, the thrust has been toward gaining the highest fidelity possible with the assumption that exposure and practice is the road to improved human performance. From an Instructional Technology perspective, simulators are part of the training process, but must be integrated with the overall training scheme. Therefore, the training conducted using the simulator is in support of an operational training curriculum, and must be developed and conducted within that curriculum. These requirements dictate the need for a mechanism which ties the human performance activities together.

THE INTEGRATION PROCESS

In order to maximize the multi-disciplined team's efforts, a system is needed to efficiently track and integrate individual activities. The application of Personal Computer (PC) based CAD/DBM provides this capability.

The Process

The detailed process for establishing the CAD/DBM system is extensive and beyond the scope of this summary. A synopsis is provided which illustrates the functional steps involved in developing the DBM system and integrating CAD with it. Appendix A to this paper provides additional insite into data-base relationships.

Seven basic steps were involved in the design of the system:

1. Determining and defining the need.
2. Defining the Activities which address the need.
3. Selection of Relational Database technology.
4. Defining the relationships between Activities (including CAD).
5. Defining specific databases which support the relationships.
6. Defining Outputs addressing user needs.
7. Implementation/debugging system.

Important characteristics of this system include:

- All databases should be able to be accessed from any other database.
- Design and authoring occur, with the creation of the database. Subsequent manipulations occur within the DBM system.
- CAD is to be a closely coupled subset of the DBM system.
- Relationships designed to facilitate database output tailored to user population.

THE POTENTIAL

The potential of such an approach to industry has vast ramifications. This approach is applicable regardless of work completed and/or planned, in any of the four activities discussed. The most intriguing and beneficial aspect of this system is its ability to enhance and strengthen existing mechanisms. The logical extension is the ultimate realization of optimized human performance. Database manipulation provides a constant monitoring and integration of activities which guarantees improved human performance.

Once the system is functioning, the expansion to address further needs is limited only by the creativity of those responsible for improving human performance.

APPENDIX A

Functional & Relational Interaction

Figure 1.0 illustrates the fundamental interaction of the DBM system, while Figure 2.0 illustrates the relational interaction. The fundamental interactions are the Design/Operational activities of the CRDR and Procedures which act as the initiating activities. The Training Materials and Simulator activities are the recipients and facilitators of the Design/Operational activities. The CAD/DBM block is the common link. The Reporting Database provides for the systematic selection and retrieval of information, for documentation, analysis, and reporting.

The relational interaction (Figure 2.0) is an extension of the fundamental interaction. This figure defines the database modules within a given activity, and illustrates the relationships. It should be noted that the databases, can be accessed or manipulated on any field in any database.

Figure 1.0

Figure 2.0

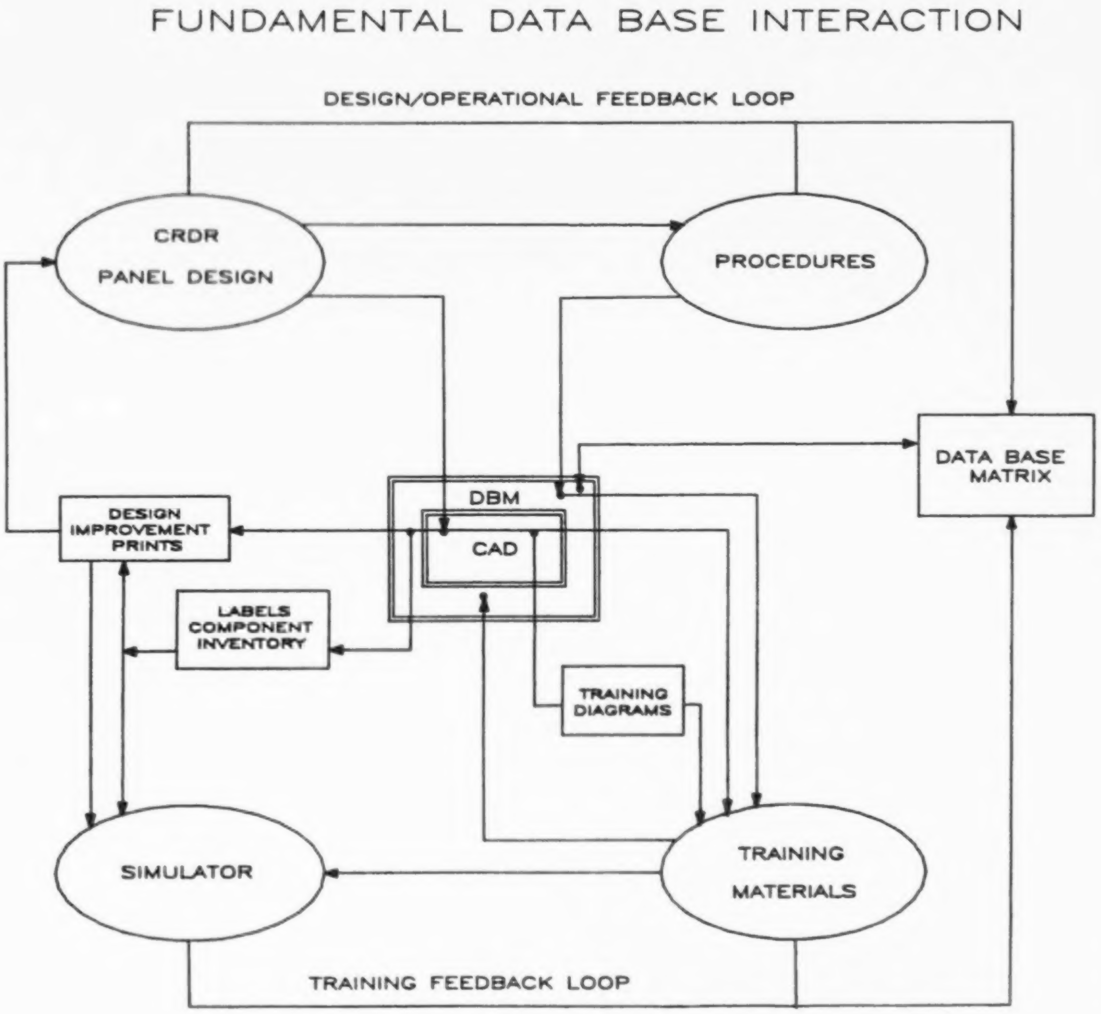
FUNDAMENTAL DATA BASE INTERACTION
DESIGN/OPERATIONAL FEEDBACK LOOP
CRDR
PANEL DESIGN
PROCEDURES
DATA BASE MATRIX
DBM
CAD
DESIGN IMPROVEMENT PRINTS
LABELS COMPONENT INVENTORY
TRAINING DIAGRAMS
SIMULATOR
TRAINING
MATERIALS
TRAINING FEEDBACK LOOP

Figure 1.0

RELATIONAL DATA BASE INTERACTION

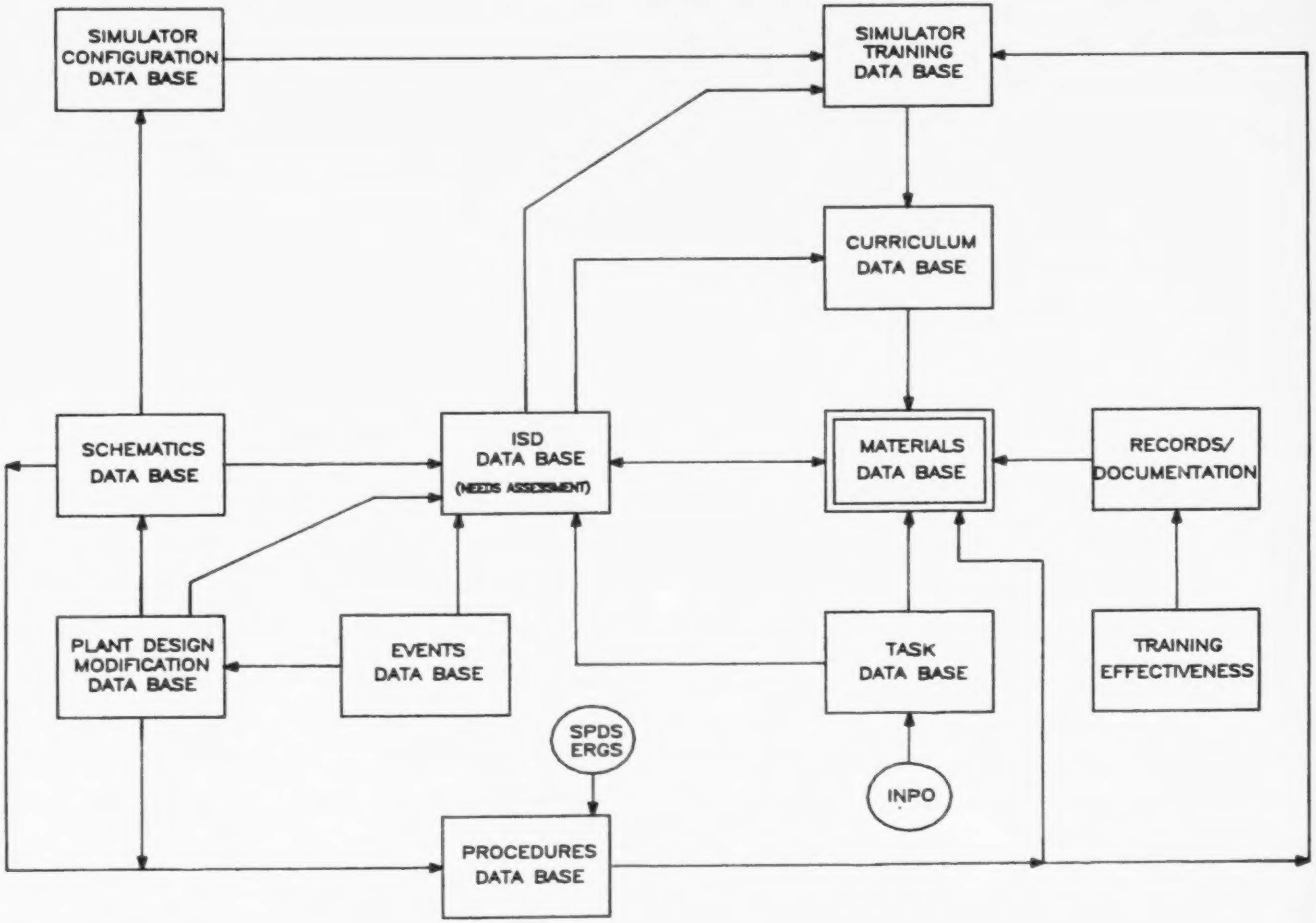
SIMULATOR CONFIGURATION DATA BASE
SIMULATOR TRAINING DATA BASE
CURRICULUM DATA BASE
SCHEMATICS DATA BASE
ISD DATA BASE (NEEDS ASSESSMENT)
MATERIALS DATA BASE
RECORDS/ DOCUMENTATION
PLANT DESIGN MODIFICATION DATA BASE
EVENTS DATA BASE
TASK DATA BASE
TRAINING EFFECTIVENESS
SPDS ERGS
INPO
PROCEDURES DATA BASE

Figure 2.0

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DEVELOPING THE DESIRE FOR CHANGE

Bill G. Gooch

ABSTRACT

This article leads the reader through the process of developing human potential by examining the assumption that development and change are synonymous concepts, and that many basic assumptions held regarding human reaction to change are false. If trainees proceed down the path filled with false premises, their task of improving performance is made more difficult.

After resolution of basic truths concerning the nature of change, the article examines the process of creating a desire within individuals that will lead beyond motivation to activation. The article attempts to identify and discuss factors that are important to creating within individuals the desire to improve their performance.

DEVELOPING HUMAN POTENTIAL

Introduction

The purpose of each article contained in this publication could be classified in one of two ways. The article's purpose is either to make new things become familiar to the reader, or to present familiar things in new, interesting and, hopefully, useful ways. It should be obvious to the reader that this discourse on developing desire fits within the parameters of the second purpose.

The training challenge is to develop human potential. In this developmental process, trainers are concerned about four primary factors. These factors relate to increasing the knowledge base of the trainee, developing new (or refining old) skills, shaping proper attitudes and developing appropriate habits. Professional development and improvement can result only from development within these four areas.

III.B.1.2

Developing KASH

The problem faced in developing human potential within the nuclear training field is the same as the problem faced in improving the potential of the people of the world. The solution to improving performance is known by most but understood by few, i.e., each person's KASH Formula[1] must be increased. The formula (K + A + S + H = Improvement) appears simple; the process, however, is complex.

It should be noted that there is a natural progression contained in the KASH Formula. The knowledge base that one possesses is instrumental in forming the attitudes that one has. An adequate knowledge base and an appropriate attitude are important in the development of desirable skills. And the application of desirable skills over time leads to desirable habits--that utopian state in which everyone takes the appropriate action and uses the appropriate method (does right things right).

Perhaps one of the reasons why development of the human resource is seldom given the attention which it deserves is that the process is so deceptively simple. Because every human being is different, each person responds to training differently. The uninitiated are likely to hold the belief that the important factor in the training process is to be firm, fair and friendly; and fair, they interpret to be treating everyone the same way.

It is not the intent of this paper to make the point that the equal treatment of unequals may very well be the highest form of inequality, nor is it the paper's purpose to point out that one of the greatest paradoxes within the training and development field is that frequently trainers accept the fact that everyone is different, but persist in treating everyone the same way in the name of fairness. The intent is to show that one of the trainer's major tasks is to create the desire for change within each trainee, and success in this developmental endeavor is directly related to the trainer's proficiency in recognizing individual differences, managing change and achieving activation.

Managing Change

A well known baseball player was quoted as having said, "It ain't over 'till it's over." This quote is included for two reasons. First, often there is value in stating the obvious, and second the author feels that the most appropriate way to introduce this section is by making the following obvious statement: Unless people change, they remain the same.*

The primary factor to consider in the task associated with the training function is human reaction to the process of change. All training and development activity is directed toward changing the trainee. This change may relate to developing within an individual the ability to think differently, perform differently, or to feel differently. If it is given, then, that a basic truth within training is that developing human potential involves stimulating people to change in desired ways, then it is important for trainers to have some understanding of human reaction to change. This understanding is important if one is to succeed in developing within a person the desire to change.

A good place to start in examining basic principles underlying the change process is with the commonly accepted truth, "People resist change." If one were to conduct a survey to determine how many trainers agreed with this commonly held truth, it would probably be discovered that most do. Because developing human beings to perform in desired ways is so interrelated with change, it is important to examine this "basic truth" more closely. For if the statement is indeed true, then the basic assumption would have to be made that people resist improving their performance or developing their potential.

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*By making two obvious statements, it was hoped that the author's anxiety level would be reduced by the fact that he was not the only one who may have wasted peoples' time by asking them to consider the obvious.

Thoughtful consideration of the statement, "People resist change," would likely lead individuals to change their opinion regarding what they believe to be true in this area. More defensible positions regarding this issue would probably be (a) people resist some change and (b) people resist being changed. If people are convinced that the changes will lead to their improvement, they are less likely to resist the change. There is, however, a force within each of us that causes us to cling to the familiar and resist the unknown. Whether you label this force maintaining equilibrium or homeostasis, the force's function seems to be to control excessive change within an individual.

To illustrate how these two truths may work in an individual, consider the following illustration. You have just been informed by your supervisor that, because of your extremely high standard of performance, your salary will be doubled. Do you resist this change, or are you more likely to wonder why this increase had not occurred sooner? Even though you may actively welcome the change, you do not perceive that the change will cause you to change the way you are. You probably feel that, even though you will have twice the income, you will be the same person that you were before.

The second factor that should be considered in the change process relates to a person's reaction to being changed. Most people perform the way they do because they have always performed that way before. Having performed in a particular manner over time, they have developed proficiency. Old habits become old friends. And just as individuals feel a deep sense of loss associated with the death of an old friend, they feel a sense of loss at having to give up familiar ways of doing things. Even if one is assured that he/she will receive a better friend, the sense of loss is not totally negated. The point is that even though improving the person's performance is the objective of training, one should not be surprised to see negative attitudes during the change (development) process.

The title of this paper is "Developing the Desire for Change." Basic considerations concerning human reaction to the change process have been presented; however, a missing aspect at this point is careful consideration of this phenomenon called human desire.

Creating Desire

If one were to investigate the psychological and sociological literature associated with motivation a definition not too dissimilar with the following may be discovered: motivation is an internal construct, intervening between stimulus and response, which fashions the nature of human response.

Perhaps one of the primary problems associated with human resource development is that those who are responsible for shaping human performance must understand motivation; whereas, those who write and share their research findings about motivation do so in language that is not easily understood.

To demystify this force referred to as motivation, please consider the following simplified definitions. The first consists of a two-word definition that the author will call "want to". The second definition consists of three words--"desire for change". When it is said of a person that he/she does not seem to be properly motivated to take a desired course of action, all that is really being said is that the person has insufficient desire or does not want to. This statement is based on the assumption that the person has the competence to perform properly but seems to be lacking the will to perform properly. If the situation exists in which an individual lacks sufficient skill, then the problem is one of lack of competence rather than lack of motivation (or desire).

Two of the major contributors to present-day practice in the area of motivation would seem to be Maslow[2] and Audrey[3]. Most people who are associated with education, training, development or management are familiar with Maslow's theory regarding a hierarchy of human needs. This hierarchy, classifying human needs (and wants), starts with basic physiological needs and moves through security needs, social needs, esteem needs ultimately to something that Maslow referred to as self-actualization.

Much of Audrey's work reveals that people strive to achieve security, stimulation, and identity and thereby eliminate feelings of anxiety related to insecurity, boredom, and anonymity.

A study of motivational literature represented by the works of such people as Maslow and Audrey would lead to a few basic assumptions that may be important to creating a desire for change within an individual. Some of these assumptions are:

1. motivation is based in relative dissatisfaction,
2. motivation is an internal force (a desire within),
3. one cannot motivate, one merely stimulates others,
4. the probability associated with one taking a particular course of action relates directly to the strength of that person's desire, and
5. if people are satisfied with the way they are performing, one should not expect them to perform differently.

After careful consideration of these basic assumptions, it would seem that the training challenge of shaping desirable human performance would be to create sufficient dissatisfaction within individuals regarding their present performance compared to desired performance. In addressing this challenge, trainers may need to address the following two questions: 1) What are the greatest sources of human anxiety, and 2) What process can be used to adjust peoples' attitudes to the point where they will take the desired action?

The literature relating to human anxiety reveals that the three major sources of human anxiety and dissatisfaction are death, guilt, and lack of purpose and/or identity. It is probably no surprise to the readers that death and guilt made the list of human dissatisfiers, but some may be asking the question, "Are death and guilt commonly used to create the dissatisfaction necessary to motivate someone to perform in a certain way?"

One does not have to study Marine Corps basic training methods to realize that the answer to this question is, yes. Consideration of Maslow's hierarchy of human needs implies that death is the obvious result if people are deprived of meeting their basic physiological needs of oxygen, food, clothing and shelter. In addition, consider the possible guilt feelings associated with a person's inability to perform in desirable ways especially at the esteem level.

It is obvious that people who are responsible for development of the human resource need to use many forces that are intended to create this desire for change. It is necessary for this desire to develop to the point where individuals will want to perform differently. To create this desire, it is necessary to examine the answer to the second question.

There would seem to be four adjustments in attitude necessary to create desire that is strong enough to cause individuals to take proper action. The first step in this attitude adjustment process is to make the individual aware of the desired action or desired performance. Second, the person should understand the performance expected. Third, the individual should develop concern regarding this inability to perform the desired task. And fourth, the individual should become sufficiently dissatisfied with his/her presentepformance capacity when compared to the performance desired. Action results from the dissatisfaction associated with being unable to perform in the desired fashion.

To summarize the purpose of this article, the following example is presented. Assume that John, a very valuable operator, was dangerously obese, and you wanted to stimulate him to lose weight. The desired action is weight loss on the operator's part. Making him aware of the problem is the first step in attitude adjustment.

Will those who are aware of the problem take the action desired? Probably not. The next step is to make certain that he fully understands the problem. Information shared with the operator to ensure understanding will not likely cause him to change his behavior regarding his eating and exercising habits.

The next step would be to create a concern within the operator regarding his present performance in relation to the desired performance. One may want to use death as the anxiety stream to create concern within the operator. Actuarial tables showing higher mortality rates for obese people may create concern within the operator. The world is filled with people who are concerned about their weight, but who do not do anything about it.

The operator must reach the last level of attitude adjustment to take appropriate action. He must be sufficiently dissatisfied with the way he is in relation to the way he should be. Many people are eating and exercising properly because a doctor may have told them that if they did not get their weight under control, they would not be around very long. They must have sufficient desire for the change, and the doctor provided the proper stimulation.

John's behavior changed through a very logical process of attitude adjustment. The process involved awareness, understanding, concern, dissatisfaction and behavior change. There is a tendency in the training area to fail to consider these necessary attitude adjustments. Why something should be performed in a particular manner may be just as important as how to perform properly.

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NON-TRAINING RELATED CAUSES OF PERSONNEL PERFORMANCE PROBLEMS: THE ROLE OF ORGANIZATIONAL VALUE SYSTEMS

R. Zaret

ABSTRACT

Training is frequently viewed as a panacea for all personnel related problems. Whenever an inexplicable incident occurs, training is verbalized by many as the solution, or worse, as the cause of the incident. All to frequently, training organizations are needlessly commissioned to develop some elaborate course, only to discover that the training is irrelevant to the problem.

While training as a solution to an incident is socially acceptable, its' use clouds the real issue. The purpose of this paper is to emphasize that there are many reasons people do not perform, many of which are related to organizational culture or values. Values directly influence all activities which we are involved in, even to the extent of how we view ourselves and how we perceive our environment. They exert a strong, pervasive influence on what and how we perform.

III.B.2.2

NON-TRAINING RELATED CAUSES OF PERSONNEL PERFORMANCE PROBLEMS:

The Role of Organizational Value Systems

Training is frequently viewed as a panacea for all personnel-related problems. Whenever an inexplicable incident occurs, training is verbalized by many as the solution, or worse, as the cause of the incident. All to frequently, training organizations are needlessly commissioned to develop some elaborate and expensive training course, only to discover that the training is irrelevant to the problem.

Various reasons account for this tendency to attach training to personnel-related incidents. Foremost it is socially acceptable; that is, training is a "safe" solution for the personnel involved, especially for the individual who is organizationally responsible and is being pressured regarding the incident, its' cause and its' fix. It is easier to simply say that the personnel involved did not know or did not know enough than to admit any of a host of other possible causes or worse, that they themselves had any link to inducing the incident. In other words, the individual responsible for resolving the problem, or their superiors who are doing the pressuring, may be, at least indirectly, a contributor to initiating the problem.

Most people will agree that individuals who are dedicated, caring and who are genuinely interested in ensuring that everything is "right" are desirable employees, whether they are operators, technicians, engineers, supervisors or managers. This person is one who is characterized as being self-directed, naturally curious, competent, able to see problems and resolve them, gets thing done even if not asked, and goes out of their way to be helpful to others. At the supervisory or managerial level, this individual has little difficulty communicating with others, instills feelings of mutual respect and personal dignity, is confident and self-assured without being arrogant, is trusting and honest with superiors and subordinates, encourages openness and honesty in subordinates, recognizes the need for and uses appropriate managerial styles with differing people, knows where the organization is headed and how to get involved. In other words, it can be said that they are good managers, are altruistic, possess insight and their orientation is both towards people and their accomplishments.

While the connection between these types of individuals and the frequency of errors is not direct, it is certainly safe to say that the probability of gross errors involving dedicated, committed individuals is greatly reduced.

So the paramount questions are how do we instill or encourage these desirable traits and their inherent behaviors and how do we maintain them? Why does it seem that there are so few people in organizations, especially large organizations, that manifest these behaviors? To discover the answers to these questions, we must to some degree, remove ourselves from the trees so that we can see the forest; the forest being the environment or organizational culture in which behavior takes place and the individual interpersonal interactions which our culture promotes.

All behavior is a result of the stimuli provided by our environment. How we respond to these stimuli are in part, a product of our organizational values system which is the heart of our culture. These values, which frequently are not verbalized directly, (which represents a value in itself), provide us with what the organization views as important, good, worthwhile and their converse. They also help shape our perspectives in terms of how we view ourselves, the people around us and our jobs.

To some small degree, organizational values are formulated by individual organizational managers, especially when the organization is geographically isolated from the larger superstructure of the company. But in most other cases, the senior manager of the company sets the values. In either case, those values are filtered, massaged and individualized as they get passed on down through the corporate hierarchy, ultimately reflecting the personal beliefs and values of the respective individual. Moreover, senior managers tend to have value systems which are consistent with that of the larger corporation, or they would not have been selected to move up the corporate hierachy.

Since values are not directly communicated, employees at all levels learn the values at-play through their perceptual filters and individual experiences. They see what types of things are emphasized, rewarded or frowned upon, whether they involve personal interactions, managerial styles, equipment, policies, communication itself, etc.

If the organization emphasizes such values as open-communications, personal well-being, trust, cooperativeness and interpersonal respect (at all levels), communicates these values and behaves consistently with them, then the associated behaviors have a high probability of occurring. If the organization emphasizes things or objects such as equipment, schedules, policies, etc. then our attitudes and focus will be directed toward these objects, perhaps at the expense of the human element. The fact that people are involved in all these things, or are required to accomplish these objects, may become cursory or be taken for granted. Furthermore, the fact that people have needs, and those needs must be satisfied for those desirable traits to manifest themselves, becomes unimportant, unattended to or ignored. Ultimately, goals, equipment maintenance, safety, etc. becomes depersonalized and entities onto themselves. Problems related to these issues become safety problems, maintenance backlog problems and control problems. As Mr. Ackoff cogently said at a recent seminar[1], "there is no such thing as a "safety" problem or a "backlog" problem but rather these labels are attached to symptoms which represent the perspective of the individual who is doing the labeling". We have become so object oriented and specialized that when we analyze things that are not what they should be,

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1. R.A. Ackoff, Keynote Address, Con Edison Central Operations Seminar, January 1987

all we can do is relate to them from our own narrow frame of reference. We then put labels on them, such as valve line-up problems, engineering problems, training problems, etc. Our labeling tends to encourage a more narrow definition and further removes us from the ability to see the big picture, as well as give us a false sense of security. We sometimes have difficulty seeing that the tardiness problem, maintenance backlog problem and the plant trip problem may all be related and symptomatic of one big problem; our fundamental inability to see the interconnection of things and people and to provide them with an environment which is conducive to satisfying their needs and that clearly encourages those traits we all value.

The most dedicated, competent and committed individual can become demoralized, demotivated, and alienated given an environment which is inconsistent, ambiguous, & browbeats people or doesn't provide avenues of communication, rewards the wrong people and goes out of their way to control every aspect of one's behavior.

Companies must recognize that over time and with differing generations of employees, the value systems of individuals vary. No longer is security a primary value of younger employees (not that security isn't important). These employees want and need to be involved in decisions affecting them, they want and need to receive feelings of accomplishment and well-being from the work they perform, they want and need an environment that will allow them to express their thoughts and feelings and above all, people want and need to feel good about themselves, by giving it their all and by contributing successfully. Therefore, it becomes clear, when organizations investigate deeper than the surface to understand many performance problems, that the culture, the value system of the organization, must be looked at in terms of the behaviors it conditions.

III.B.3.1

The following paper was not received in time to be published in the proceedings. Space is provided below for notes.

Mental Models for Expert Systems to Technology of Training.............
Dr. Harold S. Blackman, EG&G, Idaho, Incorporated

NOTES:

WHY TRAINING DOESN'T TAKE

T. R. Hyldahl

ABSTRACT

For some reason, in spite of effective program design and development and excellent instruction, trainees don't perform as expected when they get back to the job. The industry's initial response to this lack of performance is to assume that something is wrong with the training. Our strategy has usually been to attempt to change the program or the means of instruction. What we fail to realize is that trainees, for some reason, choose not to learn or to forget what was learned.

This presentation will deal with a number of other factors that would account for trainee inability to assimilate or retain information. It will also include the strategies for determining what these factors are.

The factors that will be dealt with will include:

1. Lack of attention
2. Insufficient trainee knowledge (ineffective processing of new data)
3. Emotional blocking of reception or memory
4. No immediate application of learning
5. Poor motivation for learning or remembering
6. Lack of response to trainee needs, concerns, or questions

Each of us, at one time or another, has fantasized being a famous detective. We are called upon to solve an impossible case, and, as a result of our brilliant analysis, clever strategy, and a dash of courage the mystery is solved. Today, we are all going to have an opportunity to be detectives and deal with the Great Training Caper.

Here are the clues: There is a well designed training course. Not only is it well designed, it is also well developed. In addition it has been superbly delivered. The mystery is, that in spite of all this preparation and skill, the trainee goes back to the job and does not perform as was expected. Scotland Yard, the NRC, or your management, (whoever the foil for your intelligence is going to be) speculates that the solution of the mystery is to improve either the design, development, or implementation of the program. Over your objections they call in the designers, developers, and implementers and tell them to do a better job. The designers, developers and implementers try three times as hard. They even create multi-media events and have Robert Redford do the instructing.

Still the trainees do not perform as they should. Scotland Yard, the NRC, or your management, throw up their arms in despair. "Who can solve this problem?" they wail. This is your big opportunity, but where do you begin?

You're probably saying by now, "This isn't that much of a fantasy, I've seen this mystery repeated over and over again in many different ways, and always with the same results."

I'll have to admit, it has always been a mystery to me why so many individuals schooled in the scientific method forget all their training when it comes to the area of training. It seems like technical people say to themselves, "I'll go as far as I can systematically, and then I'll depend on magic or guesswork." For the next few minutes I'm going to try and remind you about those skills that we have all been taught, and how they relate to the solving of the training mystery.

Let's attack our problem with the use of cause and effect. In this case the effect is that the employee is not performing as he/she should be. Now, as good scientists, we realize that it doesn't make good sense to just guess at what the cause for that effect is. If someone were to tell us that the cause for cancer was radiation we would be offended by their lack of scientific sophistication in making such a judgment. But when someone says that a person does not perform on the job as they should, and someone posits that the cause is training, even bright people are willing to accept that conclusion as reasonable.

So what does the good scientist, or detective, do? First of all he would probably have more than one hypothesis as to what the cause for the effect might be. Take the person not performing on the job.

There could be any number of causes to account for that effect. The person may not understand what has to be done, he may not want to do what has to be done, he may not be able to do what has to be done, his supervisor might have given poor direction, the procedures may be poor, the equipment he has to work with might be poor, he may have forgotten how to do what has to be done, he may be on drugs, he may have had an argument with his wife at breakfast, or he's just too fatigued to do it.

After having posited any number of causes to account for the effect, the second step that the good scientist or detective does is to systematically eliminate the possible hypotheses for the cause. This is a difficult step and one for which you will not find a whole lot of support. One reason, is that trainees and supervisors are somewhat reluctant to be included among the variables to explain why training is not successful. It is far easier for them to explain the problem away under the definition of "training". As a good detective you cannot be deterred by the defenses of your suspects. Truth is always your goal, so you will unrelentingly pursue your hypotheses.

There are any number of ways of going about doing an investigation. An academic researcher has an arsenal of tests and statistical tools. I perfer to ask the trainee.

Some may perceive that asking the trainee is somewhat simplistic and not nearly as sophisticated as the other diagnostic tools at the disposal of the detective. My personal experience has been that the trainee is probably the best source of determining why he/she has not performed as was expected. This is not to say that this source is always reliable or even accurate. There are many times when the trainee source does not benefit from even being honest, but then if a detective cannot distinguish between honesty and dishonesty he is not deserving of the title, detective.

To aid in the pursuit of the investigation, let me suggest some variables that you may consider when probing the trainee for possible causes of non-performance.

#1. Pre-Training Knowledge I think we often forget that adults have to know certain things in order for the new knowledge to make sense. An absurd example would be to have someone explain something to you in Chinese. The explanation would be meaningless. Studies have shown that people retain a greater percentage of new information when they are already familiar with 40% of the information being presented.

What many trainers, and managers of trainers, forget is that people have difficulty assimilating new knowledge unless they have a structure or internal organization to deal with the new knowledge. If the person has no place to store the information, nothing is going to happen to it. If I tell you that all gwumps are smerthed it doesn't mean anything unless you know what a gwump is and what the verb smerth means.

One of our problems is the very short memory span of "short term memory". Short term memory only lasts for 30 seconds. Therefore the brain has to do something with the new information it is handling within 30 seconds or it is lost. What the brain tries very hard to do, is find a file in long term memory to put the new information into so that it can be called up again when it is needed.

If the learner is having to build long term memory files at the same time he is processing new information, the circuits are overtaxed and the brain starts thinking of something more comfortable like food or other pleasures.

From the detectives standpoint, one of the reasons that the training is not taking may be because the trainee does not have enough "advanced organizers" to handle the new information coming in. As a result, no matter how good the material is, it still will not be processed. No training has taken place.

How do you solve this problem? You can estimate on the basis of the trainees experience what kind of organizers he is likely to have or you can always ask him in different ways if he is following the discussion.

A good question to address for this discussion might be, "What is an advanced organizer?" If you don't understand the concept, you may have difficulty following the discussion.

#2. Lack of Attention Closely tied to trainee knowledge is the oft discussed area of attention. We're all experts on how to get and keep attention. We all have a long series of successes with spouses, children and trainees, right? What most of us fail to remember when we are sharing all our wisdom, is what we are competing with. Take this situation for example. How many stimuli do you have that are competing with my talking to you? There are assorted noises, visual distractions, and any number of thoughts that you can call up that might be more interesting than what I am saying. You can also listen about seven times as fast as I can talk, so I am always running behind your thought processes. Unfortunately if you're like most adults it will be very hard to keep your attention for more than eight minutes, so I've already lost most of you by now.

Why any trainer is arrogant enough to believe that someone would listen to him for two hours is amazing to me. That does not mean that people, (especially trainees) are not capable of feigning attention. One of our early social skills is pretending that we are paying attention. It is considered polite to pretend you are listening. The only problems with this pretense is that it gives poor feedback to the trainer. This poor soul thinks that you are hanging on his every word and are interested in what is being said. He also believes that you understand the material. It isn't until there is a test or you get back on the job that he realizes that you were faking attention.

From the detectives standpoint, one of the reasons that training may not be taking is because the trainee is not attending. All the good information that you have to share is not getting processed because the trainee is attending to something else. There are millions of pages written on how to get and keep peoples attention. I won't take the time to reiterate all these ideas. What I have found over the years is that the only thing that most people attend to consistently is themselves. The best approach for maintaining attention is assuring that the trainee is as actively involved as he can be. Only you know for sure how to do that in your area of expertise.

#3. Emotional Blocking I'm sure it comes as no surprise to anyone to share that your emotional state does in fact influence what you learn. Trainees that are angry, anxious, or depressed are not particularly receptive to new ideas or information.

The anxious trainees because they are too busy dealing with what they are anxious about or their anxiety symptoms. If your pulse is 147 you may not be thinking about valve maintenance.

The angry trainee because the angry person is either focused on what he is angry about or, as is often the case, is angry about having to be in training.

The depressed trainees because they usually are not motivated sufficiently to feel that there is anything that you might say or do that can be of any help to them.

When you talk to people who are doing a lot of emotional blocking you receive "feeling" responses to the course.

The anxious trainee will say "The course seemed awfully long or confused." What they are saying is they were uncomfortable in the situation or because of their high anxiety everything seems confused to them.

The angry person will almost always tell you that the course was a waste of time. Either he already knew the material, the material wasn't relevant, or he knew how to present it better. The bottom line is that the angry individual usually feels undervalued, and he desires to be taken more seriously. The dynamics of how to do this is beyond this presentation, but do pay attention to those cues.

The depressed person will usually tell you the course wasn't relevant or that it was boring. What they are saying is that nothing has any value and what you are presenting isn't any different.

So how does the detective determine if emotional blocking is the reason that the training is not taking? As has been hinted at, you listen to the amount of emotional responses to the content. If your trainees are talking about ideas and content, the likelihood is that they are not doing a whole lot of blocking. If they are giving you all sorts of "feelings" about the course, it is probable that something is getting in the way of receiving your information. Of course, again, the way to find out this information is to listen to the students or ask them questions about the course.

#4. No Immediate Application People within a technical environment always perceive of themselves as being "practical", "common-sense" types of people. This may be the case in other areas of their lives or work, but it doesn't seem reflected when it comes to training. Where else in the world would you tell someone how to do something and ask him to do it six months later?

One of the most critical reasons that training doesn't take is because trainees don't have an opportunity to practice what they learn quickly enough. If people realize this, why does management wait so long after training to implement the new knowledge? My hunch is that people have a false assumption about how the human brain works. For years I have been hearing strange statements like, "We only use 20% of our brains". I have never figured out what that means, but it does lead people to visualize the brain as a bottomless pit into which you can continually drop information and retrieve it whenever desired. From our own experience, we know better.

I think we would be far better off if we compared the brain to a computer, and thought of storing information in terms of an elaborate filing system. This will help us to answer some very practical questions about information.

What happens when we receive a letter for which we have no file? We either create a file or we throw the letter away. The brain does the same thing.

What happens when we run out of room in our filing cabinet? Unless we like to proliferate filing cabinets all over our world, we clean the cabinets out. We take the items we haven't been using and we dump them.

The harsh reality is that we do the same thing with our brain. Now this isn't as conscious a decision as cleaning our desk drawers and we certainly don't get a printout. What we do get is, "I once knew how to do this calculus problem but now I can't do it."

Another example that is closer to computer filing is when the information is still there but we don't remember where it is filed or what commands to use to get to it.

Who was the singer that sang "Mule Train"? Many of us, no matter how young, may have that information stored someplace. The question is how do you get to that knowledge? My way was by seeing a picture of a wavy haired guy with a mule train on a TV show. Your way may be some completely different approach.

The bottom line on this discussion is that the brain may not be able to retrieve information if it does not use it for a while. The brain may have dropped it from it's filing system or it may not recall the commands necessary to get to it.

The good detective when confronted with a trainee that doesn't perform as he should can always ask when the desired information was learned, how quickly it was practiced, and how recently it was practiced. Having this information, you can allow "common sense" to be your guide.

#5. Training not Responsive to Trainee Needs There is something very self-centered about the average adult. For the most part, he desires something that is beneficial to him. For some unknown reason he finds it difficult to retain information for which he can find no useful application. The average adult will usually seek out the types of things he needs to know. If he has to fill out a tax form or change spark plugs, he will find out how to do it.

What the average adult has tremendous resistance to, is someone else telling him what should be important to him. All you have to do to rile up your neighbor or peer is tell him what he should learn for his own good. Even worse is to demand that he learn something for which he perceives he has no use.

Probably one of the most useless things a trainer can do is to provide an answer to a question that no one has asked. Ideally training should be based on verbalized questions of the trainee. More realistically, the training can be based on the anticipated questions of the trainee. Where we often mess up is by answering the questions that we as trainers are interested in, and assume that the trainee is interested in the same question. The best means for determining what the trainee may be interested in, is some form of survey. Probably, the more informal the survey, the better.

From the detectives standpoint, there is a good possibility that the reason that the training didn't take is because the trainee didn't perceive that there was any need for it in the first place. One of the difficulties the trainer has is that the trainee usually doesn't share this information with the trainer. The average trainee allows the trainer to go on teaching the irrelevant material without complaint. After all, one wasn't allowed to ask for relevance as a child, and many adults fail to realize that they have the right to ask for it as an adult.

Your best bet as a detective/trainer is to create a climate where the trainees share their feelings about the content of the training. It will help you to better determine needs and also to find out why certain information isn't passing the test back on the job.

We're coming to the stage where we're close to overloading your receptors, but there is one more area that should be mentioned, its the somewhat cliche oriented area of ....

#6. Motivation There has been a lot of time spent on trying to figure out what motivates someone else. The library is filled with books on the subject. There are movies on it, and you could probably have a vendor at your office by Monday to present a program for all your employees. The unfortunate thing, is, no one is quite sure what motivation means or how to do it. This is another one of those "common sense" areas.

Oftentimes when someone doesn't perform as we expect him to, we say he isn't motivated. The term "motivation" becomes a catchall for all sorts of things we don't know how to explain. I have a hunch that from a training standpoint we're better off without the term.

My reasoning is as follows: Who can motivate the trainee? Ultimately, only the trainee, right? Who is responsible for the trainee learning? Again the trainee, right? Can you make someone learn that doesn't want to? Of course not? What is your responsibility to someone that doesn't want to learn? None...So the concept of motivation is only of some value if you feel you have some responsibility to have someone do something that they do not choose to do. In other words, to go contrary to their will. There are people in the world that may have those responsibilities. I find it hard to believe the trainer is one of them.

What is helpful for the trainer is the realization that there is a cause for every behavior. People do not wander around behaving randomly. They really are trying to achieve something by behaving the way they do. The detective/trainer has to figure out what that is.

How does this apply to training? Returning to our initial problem. Why would an individual who has been taught to perform a certain function not perform it well? There could be a multitude of reasons. Why don't I wash dishes well? It has nothing to do with ability or intelligence. I don't want to wash dishes, and I found out as a youth if I did it poorly enough, no one would ask me to do it again. Not very noble, but effective.

A trainee does not respond to a question in class. Is it that he does not know the answer? Or is it he is shy and doesn't like being asked questions? Perhaps he is angry about being in class and is just rebelling. There are any number of causes to explain a behavior and the detectives concern is to determine which cause is the most plausible. Having determined the cause he may be able to do something about eliminating the problem.

I place a big emphasis on the word "may". One of the weak areas I've noted in our industry is the tendency to assume that we have solved a problem once it has been identified. Unlike television and novels, real life does not allow us the luxury of basking in success once we've explained our flawless analysis of the problem. The real world requires that others concur with our analysis, and that someone is willing to work to rectify the problem.

Being a detective is not easy work. The reason that something is a mystery is because the average person cannot solve it. The reason training does not take is not always easy to discover. I think that we're getting sophisticated enough to move beyond the "butler or training did it". There are a lot of suspects; knowledge, attention, emotional blocking, no immediate application, not responsive to trainee needs, and motivation are just the most likely of the lot.

Your most likely witness is the trainee himself. No effort should be spared in examining him to find out what he thought, heard, saw, and felt. If you remember what's involved in a good diagnosis, you should be able to be a good detective. To quote Sherlock Holmes, who spent most of his time training a scientist, "It's elementary, my dear Watson".

SITUATIONS THAT CAN HELP YOU FAIL THE NRC EXAMINATION

J.I. MCMILLEN

ABSTRACT

Conditions which can lead to failure of the NRC examination of persons who have shown great promise during the training program are explored. Several of these conditions are cited through the personel experiences of the author over the many years of administration of examinations. Although these things do not happen very often, it is concluded that training personnel should be aware of what might happen and build on their relationship with the trainees so that they can counsel them on the possible alternatives that they have in the face of unusual circumstances.

GENERIC MODELING: ENHANCING THE PRODUCTIVITY OF TRADITIONAL ISD METHODS AND PRACTICES

Gary E. Zwissler

Patrick E. Smith

ABSTRACT

Traditional methods of Instructional Systems Development (ISD) typically rely on task analysis for the identification of knowledge and sill requirements for successful task performance. Past experience with these methods has shown them to be quite labor intensive and costly.

Since the results of task analysis are essential to writing learning objectives, defining program content and preparing job performance measures, project managers traditionally have had two options for dealing with this requirement: 1) Conduct Task Analysis - schedule the time and commit the resources to complete this activity in the traditional manner, or 2) Omit Task Analysis - develop instructional materials without the requisite core information provided by the analysis.

In response to the need for a task analysis in support of systems training for plant operators at San Onofre Nuclear Generating Station (SONGS), an alternative task analysis process was developed to meet the constraints of limited project time and resources. The process, based on generic modeling, identifies task analysis data which applies across groupings of tasks for most plant systems.

Generic models represent the knowledge and skills required for the operation of any plant system. These knowledge and skills are comprehensive and are derived from an analysis of the operating requirements of a typical plant system. When applied to the task analysis process, these system operating requirements are equivalent to groups of tasks logically organized by their commonalities. Attributes, common to all tasks within each group, provide the essential operating requirements for each system. A generic model is created by validating and sequencing these similarities into an order which represents the training needed by the operator to successfully perform the tasks associated with the system for which training is being prepared.

Developing generic models requires careful analysis for the common elements of tasks across systems and a careful classification of their performance requirements. Hypothetical models must be validated with the job incumbents and revised to achieve the greatest possible fidelity between the resulting performance objective and the requirements of the job.

Applying generic models as part of the traditional ISD process involves developing and implementing methods which ensure the consistent application of the model during the design and development phases. Many of these methods become the basis for improving the management of training development projects and provide the basis for maintaining the training system in the future.

Use of generic models provides both quantitative and qualitative benefits to development projects. For those projects that must be completed with resource and time constraints, generic modeling offers a systematic approach to conducting task analysis. Instructors using materials developed with the aid of generic models report greater consistency among the instructional components than previously available from materials developed without generic models. The net effect is increased utility of lesson materials. Future applications for generic models include their use in developing test items and identifying instructional strategies.

IV.A.1.3

INTRODUCTION

This section describes the relationship between classical task analysis methods and those of generic modeling. Both approaches are reviewed within the context of the performance-base training evolution currently taking place within the nuclear industry. The following topics are addressed;

- traditional task analysis methods,
- an alternative task analysis method.

Traditional Task Analysis Methods

Background

The role of task analysis in instructional systems development is regarded by most program developers as an essential step in the process. Some of the reasons include:

- the identification of critical information needed by the worker to competently and safely perform his job,
- reducing the possibility that essential knowledge and skills will be omitted from the training,
- providing a basis for the remaining steps of the program development process.

Constraints of Task Analysis

Regardless of the potential impact that task analysis can have on training program development, the decision to engage in this activity is not always an easy choice for training management. There are typically two reasons for this; they are as follows:

- Resources; task analysis is very labor-intensive; it can consume 15 to 35 % of project resources,
- Time; on average, 12 tasks per analyst per day.

Traditional Task Analysis Methods, continued

Concerns of Management

While resources and time are two important variables that are often considered in the decision to conduct task analysis, there is also a third factor that management usually must face: that is,

> "What will I gain from engaging in this activity?"

When the anticipated results of the process are described to management, the usual response is often,

> "Why do we need to analyze something we already know how to do in order to document information that is currently available in existing training material or plant procedures?"

Classical Task Analysis

Classical task analysis procedures require the Training Analyst (TA) to focus on what the worker does under the conditions that the job is normally performed. Typically, the procedure requires that the TA begin by:

- reviewing all the major tasks for the job,
- listing the subtasks and steps included in each task,
- identifying the knowledge and skill requirements for performing the task; i.e., "What is it that a person must know or be able to do in order to complete the specified activity?

When the TA is satisfied that all that can be known about the performance requirements of a given task have been documented, another task is selected and the process is repeated.

Traditional Task Analysis Methods, continued

Classical Task Analysis, continued

Analysis continues in a straight-line fashion until all tasks that have been selected for training have been analyzed. This process is concluded with the writing of learning objectives which are derived from the knowledge and skills identified for each task or task element.

Instructor Impact

The increased emphasis that the nuclear industry has placed on the benefits of task analysis as a basic tenet of performance-based training is well founded in the "value added" to the quality of training programs and materials. However, the requirement to engage in this process adds additional complexity to the development of training material faced by the average instructor, for example:

- pressure from working in a high-risk training environment,
- new development processes which are a significant departure from past practices,
- a shift from content to performance objectives as the specification of what should be trained,
- a lack of training and experience using task analysis and objectives development methods.

An Alternative Task Analysis Method

Improving Task Analysis Methods	Task analysis as it is conducted in the real world with complex systems and unavoidable constraints, usually departs from straight-line or classical methods. Often the approach taken by the analyst working under imposed time-resource constraints amounts to little more than using rules of thumb or educated guessing.
Improving Task Analysis Methods, continued	Clearly there is a need for a process that combines the rigor of classical task analysis methods with the availability of, and orientation toward instructional content. This should result in an accelerated and less costly approach to the task analysis and the development of learning objectives; one which is compatible with the systematic development of performance-based training programs. A system of generic models for conducting task analysis and writing learning objectives, such as those prepared at San Onofre for the development of Operator training programs seems to offer an effective alternative to traditional task analysis methods. A key factor in the developing generic models is information; it is the primary outcome of the task analysis process. Emphasis is placed on what is already known about what a worker needs to know or be able to do in order to perform certain types of tasks. Essentially, generic model methodology maximizes the use of the information that is available at the time the requirement for performing task analysis arises. It takes advantage of the fact, that for a given unit of work related tasks, such as those associated with the operation of power plant systems, general categories of information can be applied to a specific tasks within that work unit.

IV.A.1.7

DEVELOPMENT AND IMPLEMENTATION OF GENERIC MODELS

This section describes the methods for developing and implementing generic models. The following topics are addressed:

- An Introduction to Generic Modeling,
- The Generic Modeling Process Flowpath,
- Descriptions of the Process Steps,
- Process Control Methods.

An Introduction to Generic Modeling

Background

Generic modeling is a method of conducting task analysis which analyzes groups of tasks for their common attributes, then generalizes the attributes to a task family.

Definition: A task family is a group of tasks which share a set of common characteristics.

When to Use Generic Modeling

The most appropriate use of generic modeling occurs in large scale task analysis efforts where;

- a high ratio of tasks to task analysts exists,
- the tasks may be grouped into families,
- the time and resources available for traditional task analysis is constrained.

An Introduction to Generic Modeling

Continued,

Benefits

When used in a task analysis project, generic modeling provides the following benefits:

- a viable task analysis approach for projects with resource and/or schedule constraints, and,
- a controlled process for developing lesson objectives.

Requirements

The use of generic modeling requires strict adherence to the following requirements in order to ensure the quality of its results;

- development of a strictly defined process,
- documentation of all activities,
- defined methods for project management, and process control,
- commitment to ongoing maintenance and support of the process.

IV.A.1.9

The Generic Modeling Process Flowpath

Introduction

The generic modeling process follows a series of well defined steps.

Since all projects have their own unique set of constraints and problems, completion of each step may vary from one project to the next. Deviation from the methods described in this paper are permissible as long as the following criteria are met.

Each step should be performed with;

- a clear understanding of necessary inputs and required outputs,
- proper process controls implemented to ensure its consistent completion by all individuals involved,

  i.e.: Use of guidelines, checklists, review and approvals, etc.
- appropriate documentation to allow for the repeatability and/or analysis of the methods used.

Flowpath Diagram

The flowpath diagram for the development and and implementation of generic models (see Figure 1) provides a sequential listing of the steps to be followed.

In the diagram, specific steps will be highlighted by capitalized text. These steps will be defined in the section, Descriptions of the Process Steps.

The Generic Modeling Process Flowpath

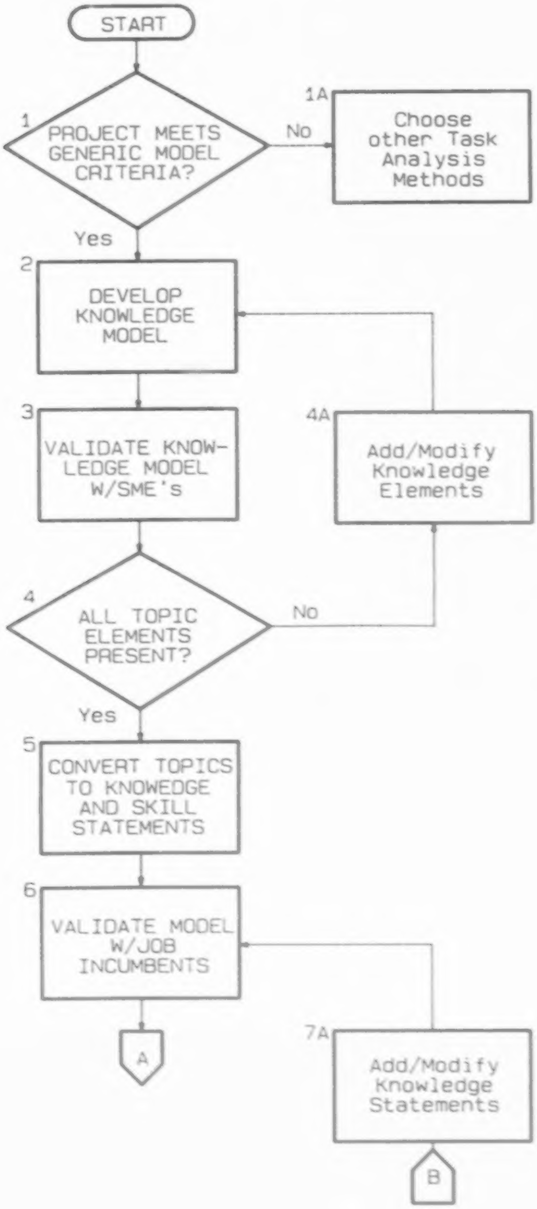
START
1
PROJECT MEETS GENERIC MODEL CRITERIA?
No
1A
Choose other Task Analysis Methods
Yes
2
DEVELOP KNOWLEDGE MODEL
3
VALIDATE KNOW-LEDGE MODEL W/SME's
4A
Add/Modify Knowledge Elements
4
ALL TOPIC ELEMENTS PRESENT?
No
Yes
5
CONVERT TOPICS TO KNOWEDGE AND SKILL STATEMENTS
6
VALIDATE MODEL W/JOB INCUMBENTS
A
7A
Add/Modify Knowledge Statements
B

Figure 1, Generic Modeling Process Flowpath

The Generic Modeling Process Flowpath

Continued,

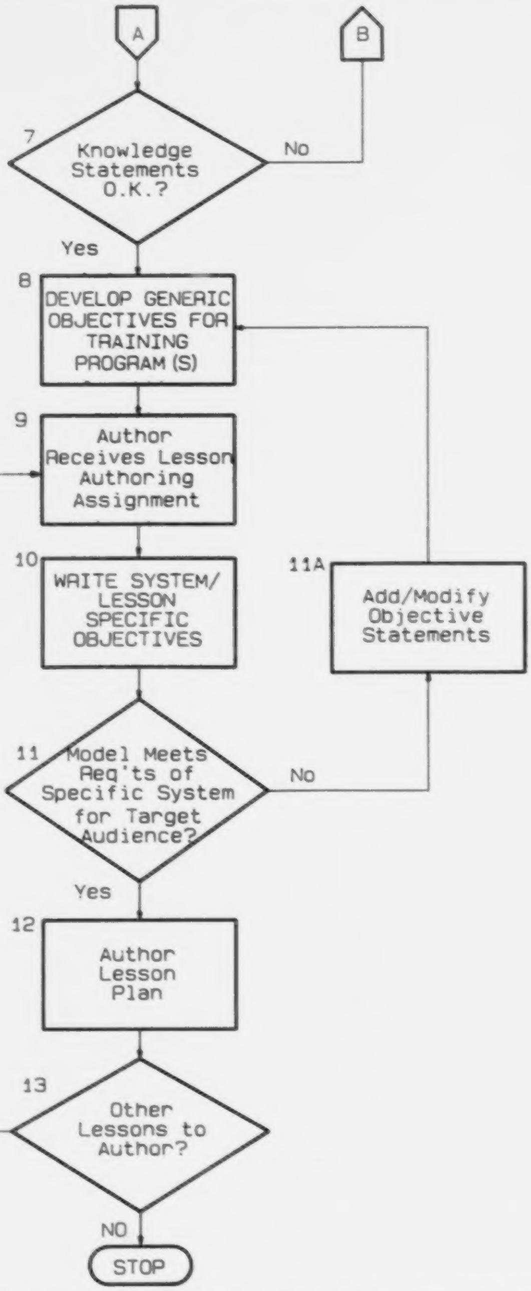
A
B
7
Knowledge Statements O.K.?
No
Yes
8
DEVELOP GENERIC OBJECTIVES FOR TRAINING PROGRAM (S)
9
Author Receives Lesson Authoring Assignment
10
WRITE SYSTEM/ LESSON SPECIFIC OBJECTIVES
11A
Add/Modify Objective Statements
11
Model Meets Req'ts of Specific System for Target Audience?
No
Yes
12
Author Lesson Plan
13
Other Lessons to Author?
Yes
NO
STOP

Figure 1, Generic Modeling Process Flowpath

Description of the Process Steps

Step 1, Project Meets Generic Model Criteria

Introduction

The first step requires that the project be evaluated for its "fit" to the generic model process.

Judging the Fit

The extent to which a project lends itself to generic modeling can be determined by comparing project conditions to a defined set of acceptance criteria.

Acceptance Criteria

Judge the applicability of generic modeling for a project by using the criteria from the table below.

If...	then...
the project includes the following conditions: o a ratio of tasks to task analysis which exceed approximately 100: 1, and, o the tasks can be divided into groups which share common traits, and, o there are limited project resources and/or time constraints,	consider using the generic modeling process.
the project includfes the following conditions: o a requirement that extensive task specific performance data be collected, and/or, o project resources and schedules support traditional methods,	consider using other Task Analysis Methods.

Description of the Process Steps

Step 1, Project Meets Generic Model Criteria, continued

Example

At San Onofre Nuclear Generating Station (SONGS), developing the Operations Training Program required the analysis of all tasks associated with the operation of plant systems.

The project conditions were as follows:

- analysis of 2448 tasks,
- three task analysts for a task/analyst ratio of 816:1,
- completion of the project within 4 weeks.

Note: Many things must be considered when determining scheduling impact. For this project, subject matter experts would only be available on a part time basis. As a result the projected daily throughput using traditional methods was approximately 4 tasks/analyst/day, yielding a total time required of 735 man days or 147 man weeks.

Based on the project conditions, a generic modeling approach was determined to be appropriate.

Non Example

Development of the SONGS Warehouse Training Program the analysis of warehouse operations task data.

The project conditions were as follows:

- analysis of 110 tasks,
- a task/analyst ratio of 110:1,
- completion of the project within 1 week.

Note: The task analyst was an experienced SME available on a full time basis. Using traditional analysis methods, the projected throughput was 32 tasks/day, resulting in a total time of 4 man days.

Description of the Process Steps

Step 2, Develop the Knowledge Model

Introduction

In step 2, the foundation for the generic model is created. The Knowledge Model forms the basis from which all other steps evolve.

The Knowledge Model is developed by completing the following steps;

1. identify the task families,
2. create the Generic Knowledge Outline for the task family.

Task Families

Task families are groups of tasks which share a set of common characteristics. Task families are usually based on groups of tasks which;

- combine to form an expected outcome, and,
- involve similar equipment or processes.

With these characteristics in mind, task families are usually identified as the System/Duty level of the job analysis hierarchy, as defined in INPO document, 83-003, Job and Task Analysis Users Manual.

Example

The task families for systems training in the SONGS Operations training programs were based on the systems within the plant:

- feedwater system,
- component cooling water system,
- 6.9 KV system, etc.

Description of the Process Steps

Step 2, Develop the Knowledge Model, continued

Generic Knowledge Outline

The Generic Knowledge Outline is a list of the knowledge that is shared by the task families. The Generic Knowledge Outline is developed by completing the follow steps.

Step	Action
1.	Determine the knowledge which are common to all task families.
2.	Order the common knowledge into an outline using a suitable sequencing strategy (see Figure 2). Note: Sequencing strategies are best selected according to the type of knowledge identified. The strategies most often used are: o logical order, o simple to complex, o most critical first. Example 1: In the SONGS systems lesson plan project, knowledge were sequenced based on the logical order implied by the equipment being operated. Example 2: Knowledge dealing with the response to events may be ordered according to the most critical first sequence. This sequence would place the most critical knowledge in the beginning of the oultline.

Example

Figure 2 provides an abbreviated example of the Generic Knowledge Outline for the systems training component of SONGS Operations Training.

Step 2, Develop the Knowledge Model Outline, continued

I. General Overview of the System

   A. System purpose/function
   B. System flow path
   C. Theory of system operation
   D. Design basis

II. Detailed Description of the System

   A. Major system components

      1. For each system component:

         a. Name/Type
         b. Location
         c. Function
         d. Principle of operation
         e. Power supplies (normal/backup)

   B. Controls and Instrumentation

      1. For each control:

         a. Name/Type
         b. Location
         c. Function
         d. Principle of operation
         e. Normal/Abnormal modes

      2. For each instrument:

         a. Name/Type
         b. Location
         c. Measurement location
         d. Function/Parameter measured
         e. Principle of operation
         f. Setpoints/Alarms

      ...

Figure 2, Generic Knowledge Outline

Description of the Process Steps

Step 2, Validate the Knowledge Model with Subject Matter Experts

---

Introduction This step involves the first validation of the Knowledge Model. The purpose of this validation is to correct any significant defects in the Generic Knowledge Outline before further development of the model occurs.

Steps To validate the Knowledge Model with subject matter experts (SMEs), complete the following steps:

Step	Action
1.	Develop the validation questionnaire. The validation questionnaire should rate each knowledge listed on the Generic Knowledge Outline by its relative importance to job performance (See Figure 3).
2.	Administer the questionnaire.
3.	Process the results. Determine the score for each item rated. Select or deselect the items based on a predetermined cut-off point.
4.	Finalize the Generic Knowledge Outline. Based on the items scores, select or deselect the items. Evaluate any items collected as anecdotal data for addition to the outline.

Description of the Process Steps

Step 2, Validate the Knowledge Model with Subject Matter Experts, continued

---

PLANT SYSTEMS KNOWLEDGE ANALYSIS WORKSHEET

System: ______________ Job/Position: NPEO ACO CRS SS

Name: ________________ Date: _________ Unit(s): 1 2/3

Use the information in the table below to rate the importance of each of the knowledge categories listed below to job performance.

0	Not Applicable	3	Important to Job Performance
1	Nice to Know Info	4	Essential to Job Performance
2	Relevant to Job		

Knowledge Category	Importance to Performing Job	Generic Object.
I. General Overview of the System		
A. System purpose/function	0 1 2 3 4	
B. System flow path	0 1 2 3 4	
C. Theory of system operation	0 1 2 3 4	
D. Design basis	0 1 2 3 4	
II. Detailed Description of the System		
A. Major system components		
...		

Figure 3, Generic Model Outline Validation Questionnaire

Description of the Process Steps

Step 5, Convert Topics to Knowledge and Skill Statements

Introduction

Knowledge and Skill statements describe how job incumbents use the topics contained in the Generic Knowledge Outline.

Application

Knowledge and Skill statements provide a frame reference for the topics contained in the Generic Knowledge Outline. In developing the Knowledge and Skill statements, each knowledge item from the outline is expanded to describe its application on the job. The final statements cover two levels of information:

- knowledge,
- skills.

Note: Skills include both psychomotor and cognitive processes.

Examples

Knowledge -- The formula for calculating Leak Rate.

Skills --
1. Use of a calculator.
2. Performing the Leak Rate calculation.

Figure 4 provides examples of Knowledge and Skill statements for the Generic Knowledge Outline used in operations training systems lesson plans at SONGS.

Description of the Process Steps

Step 5, Convert Topics to Knowledge and Skill Statements

I. General Overview of the System

  A. System purpose/function

Remember Fact:	State the purpose of the system. List the system's functions.

  B. System flow path

Remember Fact:	Draw the system flowpath.

  C. Theory of system operation

Remember Principle:	Explain the theoretical basis of system operation.
Use Principle:	Explain how the theoretical basis of system operation affects system performance.
Use Principle:	Use the theoretical basis of system operations to predict (evaluate, diagnose, etc.) system performance.

  D. Design basis

Remember Fact:	State the design basis criteria.

Figure 4, Sample Knowledge and Skill Statements

Description of the Process Steps

Step 6, Validate the Knowledge Model with Job Incumbents

Purpose Since the Knowledge Model serves as the foundation for the later steps in which lesson objectives are developed, it must accurately reflect the actual job.

Method Validating the Knowledge Model involves the completion of the following steps;

Step	Action
1.	Assemble experienced job incumbents.
2.	Review each of the Knowledge Model's Knowledge and Skill Statements.
3.	Solicit comments and suggestions from the goup regarding the validity of the Knowledge and Skill Statements. Note: A useful test of Knowledge and Skill Statement validity is to collect examples of their application to the job. A Knowledge and Skill Statement that matches the job will elict plausible examples. One requiring revision will be difficult to generalize through the use of examples.
4.	Resolve the comments and obtain group consensus.
5.	Revise and finalize the Knowledge Model.

Description of the Process Steps

Step 8, Develop Generic Objectives for Training Programs

Definition

Generic Objectives are statements which link the Knowledge Model to the training requirements of the actual job.

Derivation

Generic Objectives are derived from the Knowledge and Skill Statements. For each statement, objectives are written which describe how the statement applies to a specific position.

Generality

Generic Objectives expand on the Knowledge and Skill Statements by adding content and behaviors which are appropriate for the position being trained.

In many applications of generic modeling, one model is developed which covers several positions. For each position covered by the model, a set of Generic Objectives are developed from the Knowledge and Skill Statements.

Example

> The Knowledge Model developed for SONGS Operations Training described the skills and knowledge required by these positions;
>
> - Nuclear Plant Equipment Operator,
> - Assistant Control Operator.

Example

Figure 5 shows examples of position specific Generic Objectives written from a common Knowledge and Skill Statement. The Generic Objectives were developed for the SONGS Operations Training Program.

Step 8, Develop Generic Objectives for Training Programs, continued

---

Knowledge and Skill Statement

Explain the consequences of system failure.

Nuclear Plant Equipment Operator Generic Objective

Explain the consequences of a ______________________ failure on the ________________ system.

Assistant Control Operator Generic Objectives

Explain the consequences of a __________________ failure on the __________________ system.

Predict the expected manipulations resulting from a _________ failure on the ___________ system.

Given the following transient, explain the expected trends for the following System parameters:

Figure 5, Sample Generic Objectives

Application	Generic Objectives are used as templates from which lesson specific objectives are written. As written, Generic Objectives include the content and behaviors appropriate for the position being trained. Still missing, however, are the conditions and standards. These are added in step 10, when the Generic System Objectives are modified to reflect the specific system being taught.

Description of the Process Steps

Step 10, Write Lesson Specific Objectives

Introduction In step 10, the lesson plan author uses the Generic Objectives as a template from which lesson specific objectives are written.

Steps The Generic Objectives are translated into lesson specific objectives by completing the following steps.

Step	Action
1.	Review the Generic Objectives for their applicability to the topic being taught.
2.	Rewrite the selected Generic Objectives into lesson specific objectives by adding conditions and standards which are appropriate for the topic being taught.
3.	Complete the Lesson Specification forms for the lesson specific objectives (See Figure 7).

Example Figure 6 shows examples of lesson specific objectives developed for SONGS Operations Training Program from their parent Generic Objectives.

Step 10, Write Lesson Specific Objectives

SYSTEM FLOWPATH

Generic Objective

Describe the flowpath through the ___________ system.

System Specific Lesson Objective

Describe the flowpath of power to the RCP buses during shutdown/start-up and power operations, including all transformers used in their most preferred order.

SYSTEM OPERATION

Generic Objective

Predict the consequences of (component name or system name) failure on the _____________ system.

System Specific Lesson Objective

Explain the consequences to 6.9 KV System operations resulting from a failure of the following components:

- Unit or Main Transformer
- Reserve Auxiliary Transformer (same unit)
- Reserve Auxiliary Transformer (different unit)

Figure 6, Sample Lesson Specific Objectives

Process Control Methods

Introduction

The process associated with developing and implementing generic modeling requires a system of controls to ensure consistent results.

The controls usually involve the following activities:

- collecting feedback on the accuracy and validity of the Generic Objectives,
- document control,
- user training,
- product review and approvals.

Collecting Feedback

Background

Although the Generic Objectives are written in step 8, their development is really an iterative process which depends on subsequent revision. As the experience base grows, areas missing in the original Knowledge Model will become evident by the lack of Generic Objectives addressing those topics.

To correct this situation, Generic Objectives must be written which cover the missing topics. Revising the Generic Objectives list should be accomplished by following the same controlled process as used in the initial development.

Collecting Feedback, continued

Revising the Generic Objectives

To revise the Generic Objectives, follow the steps in the table below.

Step	Action
1.	Collect feedback from the Generic Objective Users. Feedback should be specify the types of content and behaviors missing from the existing Generic Objectives.
2.	Assemble a SME review committee to determine the topics to be added to the Generic Knowledge Outline. Refer to Step 2 of the Process Flowpath.
3.	Add the required topics to the Generic Knowledge Outline.
4.	Write Knowledge and Skill Statements for each topic added to the Generic Knowledge Outline.
5.	Validate the new Knowledge and Skill Statements.
6.	Write Generic Objectives for each of the new Knowledge and Skill Statements.
7.	Validate the new Generic Objectives against the identified deficiencies.
8.	Revise the current Generic Objectives list and distribute to the user.

Process Control Methods

Document Control

Background

Step 8 in the process for revising the Generic Objectives requires the new Generic Objectives list to be distributed to the user. A critical point of process control occurs in this step.

Distributing successive revisions to the Generic Objectives list to the users may result in confusion. A method should be developed which addresses the problems associated with the users retaining and using outdated revisions of the list.

Example

During development of systems lesson plans for SONGS Operations Training, the following document control methods were used;

- listing of date and revision numbers on the cover page,
- posting the date and revision number of the current list in a specified location,
- controlled distribution of the revised lists.

Note: As each successive revision to the list was distributed, the previous list was collected and destroyed.

Process Control Methods

User Training

Background

Training the users is an important part of ensuring consistent and accurate application of the Generic Objectives. For many users, the Generic Objectives provide their first exposure to a controlled systematic development process. As a result, the new process is often received with considerable anxiety.

Benefits of Training

Training new users on the proper application of the Generic Objectives provides the following benefits:

- anxiety reduction,
- understanding of expectations,
- delineation of responsibilities,
- consistency of resulting products.

Implementing the Training

Training may be accomplished by using several different methods. At SONGS, we used the following:

- classroom instruction,
- On-The-Job training (OJT).

Classroom instruction was used for situations involving more than four trainees.

OJT was selected for situations involving one to three trainees.

Additional Benefits

By formalizing the training, additional benefits may be realized. At SONGS, successful completion of the training satisfies the requirements for the Lesson Plan Development portion of the Instructor Training Program.

Process Control Methods

Product Review and Approvals

Background

A final step in the process of ensuring consistent and accurate use of the Generic Objectives involves a two phase review. This review consists of an instructional check followed by a technical check.

Instructional Review

During this activity, a check is made of the author's use of the Generic Objectives by an instructional technologist who evaluates the objectives from a process perspective based on the following:

- accuracy of the content and behavior translation from the Generic Objectives to the lesson objectives,
- completion of appropriate documentation,
- construction of the lesson objectives.

Technical Review

During this activity, a check is made of the author's use of the Generic Objectives by a senior instructor/subject matter expert who evaluates the objectives based on the following:

- accuracy of the technical content,
- completeness of technical content.

Product Review and Approvals, continued

Forms

An important part of the review and approval process involves consistent inputs and outputs. The use of standardized forms aids in collecting the same information from all authors.

At SONGS, lesson specific objectives are written on Lesson Specification Forms. The Lesson Specification Forms provide the following information:

- the lesson specific objectives (developed from the Generic Objectives),
- the Generic Objective from which the lesson specific objective was derived,
- test item number(s) for the lesson specific objective,
- applicable references for the lesson specific objective,
- suggested instructional strategy for the lesson specific objective.

Benefits of Lesson Specifications

Lesson Specifications which include the above information provide the users with three types of important information;

- the material to be reviewed and approved,
- an audit trail which documents the link between the Generic Objectives (task analysis), lesson objectives, test items and instructional strategies,
- the micro design of the training program as represented by the instructional strategies.

Example

Figure 7 provides and example of the Lesson Specification Form used at SONGS.

Lesson Specification Form

Enabling Objective

Lesson Title:

Enabling Objective # ______ : (Lesson Specific Objective text is written here)

Classification:

Related Objective Number:

Test Format: Short Answer ( ) Fill-in ( ) M/C ( ) T/F ( ) Performance ( )

Related Test Item Number:

Related OJT Qual Card Item:

Related References:

STRATEGY

Main Idea:

Keypoints:

Presentation:

Examples:

Practices:

Feedback:

Figure 7, SONGS Lesson Specification Form

FUTURE APPLICATIONS OF GENERIC MODELING TO TRAINING

Applications Within ISD Operations

This paper has focused on the use of generic models in the analysis of tasks for the development of training materials. There are, however, other potential uses for this concept within the instructional systems development process:

- developing test items,
- identifying appropriate instructional strategies.

Future Applications to Training

Generic models have potential application to other areas of training within the nuclear industry. Those situations can be characterized as follows:

- tasks that can be logically grouped into categories that share a common attribute; i.e., system, component, duty area or work unit;
- the task pool exhibits a set of informational data points or topics that are common to all tasks in the category;
- task performance within a given category has a common set of learning or knowledge prerequisites.

There are several areas of nuclear training where the generic model concept can be applied with potential success. These include:

- Operating and Administrative Procedures tasks;
- Systems maintenance tasks, electrical, mechanical, and electronic components troubleshooting, repairing, diagnosing and replacing tasks;
- Quality Control inspection tasks.

SUMMARY

Benefits Use of generic models at SONGS gave produced several important benefits to the development of Operations Training Programs. These benefits are:

- increase in the level of information quality and task consistency of both task analysis and learning objectives;
- reduction in the time required to complete task analysis and objectives development by an estimated 50 percent;
- improved consistency in the development of lesson plan elements and in the process for producing training materials.

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Figure 1, Generic Modeling Process Flowpath

Figure 2, Generic Knowledge Outline

Figure 3, Generic Model Outline Validation Questionnaire

Figure 4, Sample Knowledge and Skill Statments

Figure 5, Sample Generic Objectives

Figure 6, Sample Lesson Specific Objectives

Figure 7, SONGS Lesson Specification Form

IV.A.2.1

USING A MICRO COMPUTER BASED TEST BANK

Reed T. Hamel

ABSTRACT

Utilizing a micro computer based test bank offers a training department many advantages and can have a positive impact upon training procedures and examination standards. Prior to data entry, Training Department management must pre-review the examination questions and answers to ensure compliance with examination standards and to verify the validity of all questions. Management must adhere to the TSD format since all questions require an enabling objective numbering scheme. Each question is entered under the enabling objective upon which it is based. Then the question is selected via the enabling objective. This eliminates any instructor bias because a random number generator chooses the test question. However, the instructor may load specific questions to create an emphasis theme for any test. The examination, answer and cover sheets are produced and printed within minutes. The test bank eliminates the large amount of time that is normally required for an instructor to formulate an examination. The need for clerical support is reduced by the elimination of typing examinations and also by the software's ability to maintain and generate student/course lists, attendance sheets, and grades. Software security measures limit access to the test bank, and the impromptu method used to generate and print an examination enhance its security.

The primary purpose of test bank is to utilize a micro computer to generate an examination within a very short time period. This is accomplished by the software's hierarchical design of one (1) course title linked to many enabling objectives, and many enabling objectives linked to even more test questions. (For example, the Authority's goal is five (5) test questions per each enabling objective.) After selecting an enabling objective, test bank allows the instructor to either select the test questions randomly or to permit him/her to pre-review the questions in order to make a selection.

Before accepting test questions into any bank, the questions must be reviewed to ensure compliance with plant Training Systems Development (TSD) policies and procedures. All test questions require an enabling objective. Licensed operator questions follow a special procedure noted in Table 1. (See Appendix.)

This procedure includes operations staff input to the review cycle. The loop ensures a high degree of validation and is a means to provide direct feedback to training program content. Licensed operator enabling objectives receive a point value. This ensures that all questions linked to an enabling objective have the same point value. Another advantage of the review cycle is the consensus attitude embodied in the cycle. Review participants are asked to read the question and complete a short questionnaire, assign a point value, and draft an answer. (Table 2, See Appendix.) The Training Department evaluates the responses and strives to reach a consensus. Once achieved, the question can then be entered into the bank.

The micro computer based test bank was developed in-house by New York Power Authority staff.* It is operated by the instructor initiating the examination. It is menu driven with each menu level password protected. (See Table 3.)

Table 3. Test Bank Master Menu

```
        TRAINING DEPARTMENT
            MASTER MENU

     1. Test Bank Data Entry Menu
     2. Test Bank Report Menu
     3. Student Information
     4. System Utilities Menu
     5. Supervisor Menu
     6. Exit to Operating System

     Please Enter Your Selection :__:

     Please Enter Valid Password.
```

Test Bank has three major functions. The first is data entry and editing of test questions. Second is the examination output, and third is student information and grades data.

---

* Test bank utilizes Dataflex by Data Access Corporation., Miami, Florida

For data entry, the course description and enabling objective are requested. (See Table 4.)

Table 4. Test Bank Question and Answer Data Entry Screen I

```
                 TRAINING DEPARTMENT
         QUESTION AND ANSWER DATA ENTRY SCREENS

1. Please enter the Course Title: ________________________
                                  Depress "F2"-Find Course

2. Please enter the Course Number & E.O.:
                             _____ . _______________________
                                      (No Spaces)

Total number of questions presently for this E.O. :__:

                DEPRESS "F8" FOR HELP
```

Once entered the bank is ready to accept either a multiple choice or essay question. This fixed record length program will hold up to 1050 characters for the question and over 1700 characters for answers. Essay is used for typical essay questions, true-false, fill-in-the-blanks and matching columns. (See Table 5.)

Table 5. Test Bank Question and Answer
Data Entry Screen II

```
Total number of questions presently for this E.O. :___:
Question Type: (M)ultiple Choice  or  (E)ssay  :__:

:__________________________________________________________:
:__________________________________________________________:
:__________________________________________________________:
:__________________________________________________________:
:__________________________________________________________:
    DEPRESS ENTER TO ADVANCE TO THE ANSWER SCREENS
```

Test bank has no graphics capabilities. Therefore, line diagram or drawing answers must be noted by reference. All test questions are saved in ASCII Code. This allows most Greek letters and mathematical symbols to be used.

Of course, the real value of this micro computer based test bank is the ease and efficiency of initiating an examination. A specific examination can contain up to 75 test questions and is used for daily or weekly tests. The licensed operation version also permits the instructor to prepare mock "NRC License Operator" examinations via the eight (8) NCR categories (Table 6, See Appendix.)

For either type of examination, the instructor must answer the prompts. These include today's date, test date, course title, test number and number of test questions. (See Table 7.)

Table 7. Test Bank Initiate Examination Screen I

```
                    TRAINING DEPARTMENT
                INITIATION OF AN EXAMINATION

Today's Date: 1/29/87

Please enter the following information:

Course Title: Atomic Absorption____________________________:
                  (Depress "F2")

Date the test is to be administered: 1/29/87_____________:
Section Number (if more than one section being taught):___:
Test Number :_2_:
Number of required questions for this test :_3_:
Remarks:_____________________________________________________:

DEPRESS RETURN TO ENTER DATE-TAB TO RETURN TO PREVIOUS
WINDOWS       DEPRESS "ESQ" TO EXIT
              DEPRESS "F8" FOR HELP
```

Then the course enabling objectives are displayed. (See Table 8.) The instructor chooses from this list until the number of questions selected equals the number requested.

Table 8. Test Bank Selection of Enabling Objectives Screen 2

```
                     TRAINING DEPARTMENT
               SELECTION OF ENABLING OBJECTIVES

Today's Date:  1/29/87

Course Title:  Atomic Absorption          Number:  CSPT02

EO's for this Course:                     Questions Available
                      1  2.2.1                  3
                      2  2.2.2                  5
                      3  2.2.3                  5
                      4  2.2.4                  5
                         NO MORE EO's

To select an EO enter a number (1 - 10)    (    )

DEPRESS "F10" FOR MORE, DEPRESS "F9" TO START OVER,
DEPRESS "F8" FOR HELP
```

After selecting the enabling objective, the instructor can choose to select a question randomly or preview the first 70 characters of the question. (See Table 9.)

Table 9. Test Bank Select Question Screen 3

TRAINING DEPARTMENT
SELECT TEST QUESTIONS RANDOMLY

Course Title: ATOMIC ABSORPTION Number: CSPT02

Choice	Selected E.O.	Questions Available
4	2.2.4	5

You have requested 5 questions for this test. 0 have been selected so far.

How many questions do you want selected from this enabling objective ? ____

Do you wish to pre-review Test Questions for the selected E.O.? (Y/N) ____

DEPRESS "F8" FOR HELP

When the number of questions selected equals the number requested, the test automatically prints one copy of a pre-format examination, a separate answer sheet and a cover sheet. All printing includes headers, spacing, question numbers and page numbers. this whole process, depending upon the number of questions chosen and how much pre-review takes place, can literally take only minutes. The number of test questions requested does not inhibit the programs speed. The test is archived to a file and the requisite examination copies are photocopied. (Tables 10, 11 and 12. See Appendix.)

The third major area is student information. It compiles student data such as name, course, social security number, title and test grade. Various reports permit tracking student course enrollments, grades and final average grade.

In summary, the positive impacts of the micro computer based test bank are as follows:

a. Management review cycle and consensus.

b. Significant time reductions in initiating examinations. Typically a reduction from two (2) hours to fifteen (15) minutes.

c. Ease of operation.

d. Elimination of clerical typing.

e. Security considerations through computer logins, password protection, and impromtu test generation.

f. Training administration support through course reports, student tracking and grade matrix capabilities.

g. Database compatability for both weekly examinations and mock "NRC Licensed Operator" examinations.

h. Program's flexibility to operate in almost any test environment utilizing an TSD format.

Table 1

FLOW CHART OF TEST QUESTION REVIEW CYCLE

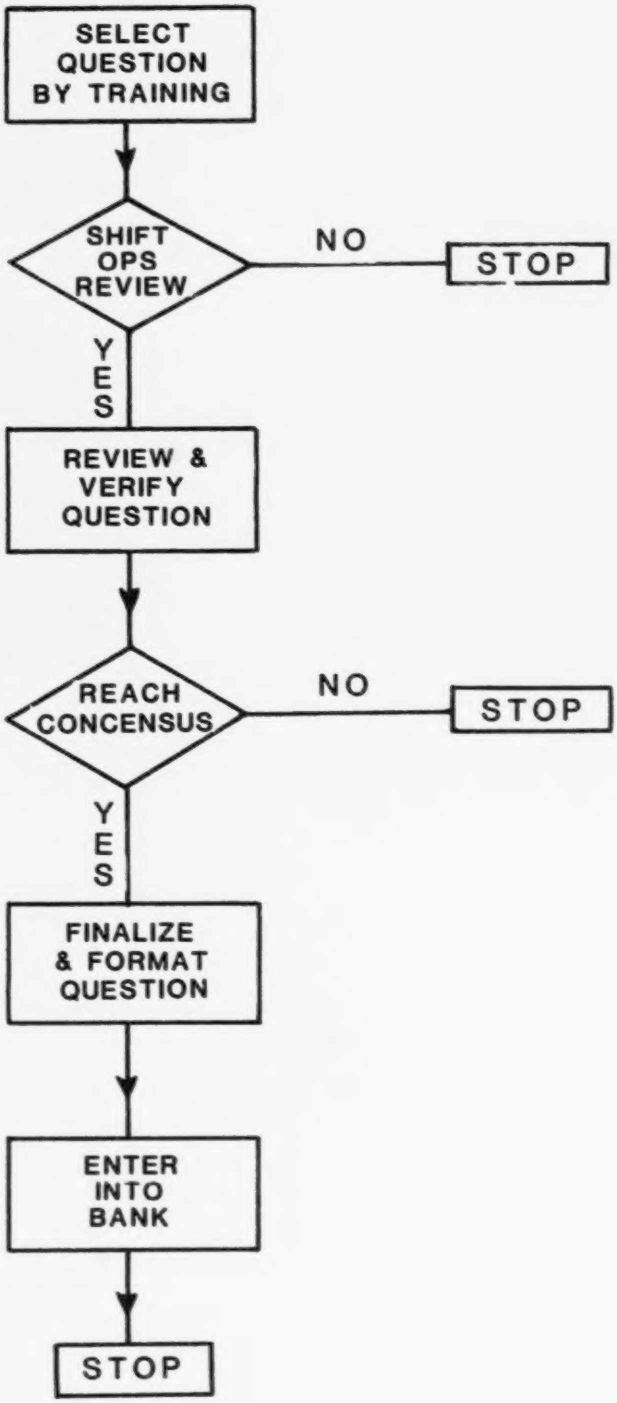
SELECT QUESTION BY TRAINING
SHIFT OPS REVIEW
NO
STOP
YES
REVIEW & VERIFY QUESTION
REACH CONCENSUS
NO
STOP
YES
FINALIZE & FORMAT QUESTION
ENTER INTO BANK
STOP

Table 2. Test Bank Questionnaire Used At James A. FitzPatrick Nuclear Power Plant

The following guidance is offered in your evaluation of the questions and answer(s):

1. Review the question BEFORE looking at the answer provided.

(Y)(N)(N/A) 2. Does the question adequately test the knowledge requirements of its corresponding Enabling Objective?

3. Does the question solicit a specific response which is a "required" knowledge or skill for your job position?

4. Answer the question in your own way.

(Y)(N)(N/A) 5. Compare YOUR answer to the answer key; are the same key points identified?

(Y)(N)(N/A) 6. Does the point value(s) assigned to the answer match your expectations from the question? (An aid to answering this question is the qualification standard for your job position.)

7. Make your comments in the space provided below. (Please comment to any "NO" response).

Table 6. Initiate "NRC" Examination

Training Department
Initiation of Operator Examination

NRC CATEGORY

1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
2. Plant Design Including Safety and Emergency Systems
3. Instrument and Control
4. Procedures - Normal, Abnormal, Emergency and Radiological Control
5. Theory of Nuclear Power Plant Operation, Fluids and Thermodynamics
6. Plant Systems: Design, Control and Instrumentation
7. Procedures: Normal, Abnormal, Emergency and Radiological Control
8. Administrative Procedures, Conditions and Limitations

Please Enter Your Selection :__:

DEPRESS "F8" FOR HELP

Table 10. Sample Test Bank Examination

James A. FitzPatrick Training Department - Examination

Course #: CSPT02
Section #: 1

Test Date: 01/29/87
Test #: 2

1. Plot the following data in the best way possible and use your plot to determine the concentration of an unknown with a transmittance of 23%.

Standard Conc. (ppm)	% Transmittance
0.0	100%
0.5	40.2%
1.2	11.3%

2. Contrast high and low dispersion gratings and explain why one is preferred over the other.

3. When creating a dispersion grating, blazing is the technique used. What is it and why is it used?

Table 11. Sample Test Bank Examination
Answer Sheet

James A. FitzPatrick Training Department
Examination Answer Sheet

Course #: CSPT02	Test Date: 01/29/87
Section #: 1	Test #: 2

E.O. #: 2.2.1

1. Percentage transmittance = 23, so the conc. = 0.80 ppm.
    A = log (1/T)
    A = log (1/1) = 0.0
    A = log (1/.402) = 0.396
    A = log (1/.113) = 0.947
    A = log (1/.23) = 0.638
    Refer to Reference 1 Supplement for plot drawing.

E.O. #: 2.2.4

2. High dispersion gratings have a much greater line density which provides much greater interference in some areas and much greater additivity in others. The result is a better dispersal of wavelengths with the high dispersion grating which allows us to obtain narrower peaks and less interference, use larger slit widths which in turn results in less amplifier gain and better sensitivity through the reduction of noise.

E.O. #: 2.2.4

3. Blazing is the process of making gratings by carving V-shaped grooves into a reflective surface. It allows the creation of a diffaction grating which gives good accuracy and dispersion, yet is relatively inexpensive.

Table 12. Sample Test Bank Cover Sheet

New York Power Authority
James A. FitzPatrick Nuclear Power Plant

Examination/Quiz
Cover Sheet

Examination Title: Atomic Absorption   Test Date: 01/29/87

Examination Approval: ______________________________
(Program Administrator)

Open Book ( )   Close Book ( )   Time Limit: _____

Authorized Reference
Material: ____

Minimum Acceptable Grade: ___ Grade: ___ Graded By: ____

Student Data

Name: ___________________________ S.S.#___-___-____
(Last) (First) (M.I.)

Employer: _______________________ Date: _____________

Department: _____________________

Guidelines

1. Remain seated and quiet during the examination.
2. If you have any questions during the examination, raise your hand. Your instructor will provide clarification wherever possible.
3. You are expected to do your own work and not help anyone else.
4. Use only the authorized reference material.
5. At the completion of this examination, you are to sign the following certification.

I certify all answers contained in this examination are my own. In addition, I have not received nor given any unauthorized assistance, nor have used any unauthorized references.

Student Signature: ______________________ Date: _________

THE ROLE OF SIMULATOR TRAINING IN DEVELOPING TEAMWORK AND DIAGNOSTIC SKILLS

W. E. Grimme

ABSTRACT

A review of the evolution of the control room team is necessary to understand team training needs. As control room responsibilities have increased and members have been added to the operating crews, teamwork and strong leadership has become crucial to the efficiency of these operating crews. In order to conduct effective team training in a simulated control room, it is essential that the fundamental principles of role definition and common team values are fully developed.

The diagnostics model used to develop problem-solving skills must be adaptable to the dynamic environment of the control room. Once the fundamental principles of team building and a good diagnostics model are mastered, many training techniques using a simulator are available to perfect the development of team building and diagnostic skills.

Any study of the current training techniques being used to develop teamwork and diagnostic skills in control room crews is greatly enhanced by a review of the evolution of today's control room team. Today's team training programs are largely products of trainers who have had the opportunity to observe and work with hundreds of operators over thousands of hours during this evolutionary phase. These trainers have been supported by specialists in the fields of human behavior and management techniques, and their combined efforts have resulted in observable improvements in the teamwork and diagnostic capabilities of the operators and supervisors who have participated in the training programs developed by them.

Probably the earliest idea in the movement toward team building in control room crews was the concept of the operator and the senior operator, or the RO and the SRO. This early distinction seemed to provide some of the elements such as leadership and coordination of efforts thought to be needed in a successful team. In actual practice, however, the distinction really only indicated the depth of study required for each position. While the RO studied how to operate systems and monitor parameters, the SRO studied these RO skills and, in addition, the theory and the bases for actions taken and limits observed. The end result of this effort was essentially a control room with two operators, one of whom could explain why things were being done. Very little actual teamwork was seen with this arrangement. Even though the RO and SRO may have worked well together, there was really no guidance, leadership, or coordination of effort to achieve efficiency.

The actual difference between the RO and the SRO became even less noticeable after 1979 when increased emphasis was placed on training in thermodynamics, degraded core concepts, and other areas of plant physics. Suddenly, while the SRO was required to study more of the background topic, the RO found himself being trained in areas previously thought to be "SRO material."

In 1981, two new concepts came into play to further complicate the structure of the control room team. One of these concepts was the addition to the team of a degreed engineer to supplement the SRO in the engineering aspects of plant operation. This engineer, the Shift Technical Advisor, or STA, was potentially a very valuable resource, but to be used by whom? and how? The answers to these questions were not supplied with the STA.

The other concept affecting the control room team was the new requirement that SROs receive training in the areas of problem-solving, decision-making, and prioritizing. This training seemed to indicate that the SRO was the man to whom the team could look for leadership. He would utilize the resources of the ROs and the STA to solve problems, make decisions, and set priorities. One big obstacle to this goal was the fact that, typically, the SROs were chosen based on their abilities as ROs: usually, a good RO became an SRO. Often this new and poorly defined role was not a comfortable move for the good operator and the new SROs were sometimes slow to become leaders, problem-solvers, decision-makers, and priority-setters.

Another problem started showing up in the 1980's. The established SROs, some with many years of experience, began to be left behind as the new SROs continued to study the physical sciences in their training programs. Also, the older SROs were faced with learning new ways to solve problems, make decisions, and set priorities and sometimes couldn't understand why their experience in these areas didn't seem to count. Why weren't the techniques that they had developed over years of experience acceptable?

The general training situation that existed through 1985 was as follows:

1. ROs and SROs generally trained together, although not necessarily with their own teams.

2. STAs typically did not train with the team that they supported.

3. SROs continued to be trained in the team-leader skills of problem-solving, decision-making, and setting priorities, but these skills were not really catching on; most of the team members elements required for successful implementation of these skills were missing.

4. All the elements for a successful team consisting of supervisors, operators, and technical resource people were in place but had not really been brought together.

In 1985, the team building and diagnostics movement began in earnest and genuine commitments were made. INPO provided some good fundamental guidance in TQ503 -- a team building plan using a four-module format. The four modules were basically communications, diagnostics, case study, and application; this last module was to be set in a simulated control room.

The remainder of this paper describes General Electric's Nuclear Training Services experience in assisting several utilities in their team training efforts.

The first teams to experience team training based on the first three modules of INPO's TQ503 consisted of operators, supervisors, and sometimes STAs. Bringing these team elements together for the purpose of exploring team building and diagnostics was very enlightening with regard to some of the problems that needed to be overcome. One of the very first observations was that the individual team members did not really know what was expected of them, nor did they know what they could reasonably expect from the other team members. Another observation was that, in some cases, the stresses resulting from undefined team responsibilities were causing areas of personal conflict. These personal conflicts could not be resolved satisfactorily within the present team structure.

These two observations prompted the first modifications to the team building and diagnostics training. The original training program seemed to have been developed with too many assumptions; the program needed to start with some even more fundamental concepts and exercises than hitherto.

The first improvement consisted of exercises and seminars aimed at defining roles. The lecture format was deliberately avoided and seminar-exercise techniques were used to turn role definition into a set of solid expectations that the operators, supervisors, and technical advisors could depend on. Each individual team member was asked to describe his own perception of his role and his perception of other member's roles.

Feedback from the other members was then solicited. Eventually, the perceived and real expectations matched. Thus, these seminar-exercises relieved the stress of unknown responsibilities and tore down the initial obstacles to effective team building; they also formed the basis for individual team member accountability.

The next step was to work on establishing team values. Without common values, the energy of a team is diminished through dispersion. It was observed in initial groups that, even though all the individual values had the same name of "operate the plant safely," each team member typically had a different idea with regard to achieving this goal. By establishing common values, a team culture was formed whereby the common goal overrode the personal preferences of the individual team members. The crew members were actually beginning to form a team.

The title of this paper is "The Role of Simulator Training in Developing Teamwork and Diagnostic Skills." By now, you are probably wondering if there is a role for the simulator in developing team building and diagnostic skills. The truth is that until a disciplined team, with common values, with leaders who hold the team members accountable for their actions and responsibilities, and with members who know what they can expect from others and what is expected of them, enters the simulator, team training may take place but team building cannot. The stresses resulting from unknown responsibilities and conflicting goals, combined with members holding back their performance because there is no accountability, can actually prevent a team from forming. But when the fundamentals are understood and team agreement is reached, the simulated control room training becomes the team training.

With these fundamentals established, then, team building and diagnostics moved into the simulated control room. The initial experience was very good. Team members who had shared the classroom experience of team building and diagnostics were visibly more comfortable in their roles and exhibited more focussed energy in their approach in controlling the plant.

Along with this new phase of training, however, came another observation that called for a change in course strategy.

The second module in the team building and diagnostics training consists of diagnostics (the problem-solving), while the third module consists of tabletop case studies to practice diagnostic skills. The initial approach used in diagnostics training was a management style problem-solving and decision-making technique. The technique worked very well on "paper plant" problems; however, the team participating in the training had a difficult time making the transfer from paper to the simulated control room. The diagnostics approach was not natural to a dynamic, operating environment such as a simulator. A more natural problem-solving process was needed in order to produce a functional problem-solving team. The source for the new diagnostics system came from observation of the operating crews. It was found that the strongest problem-solving crews used a process of iterations on discrete pieces of information made in an orderly fashion. Based on this observation, an algorithmic approach to problem-solving was implemented in the team building and diagnostics training. This approach proved to transfer more naturally into the dynamics of the control room.

With the team culture developed and established and the algorithmic diagnostic model introduced, polished simulator team building and diagnostics training could finally be conducted. Prior to each simulator session, a review of the classroom concepts of team values, role definitions, diagnostics, and communications is held. These reviews serve to reinforce concepts and focus each team member's attention toward the team building and diagnostics portion of the simulator training. The review sessions include additional tabletop practice and experience report case study. The topics are very well received by the members of the operating teams. In fact, it seems that they welcome the opportunity to begin their simulator training sessions with a "team warmup" in which they can reestablish and reinforce the team culture development and review the common team values.

Following the classroom "warmup," the training is moved to the environment of the simulated control room. Several approaches are utilized depending upon the particular needs of the plant's Operations Department. Once the training techniques are defined, they remain constant for all crews of an Operations Department.

One training technique that has become fairly common is the directing of all trainer-to-crew questioning through the shift supervisor. The goals of this technique are to strengthen the supervisor in the eyes of the team members and to provide the supervisor with extensive practice in the use of his team resources. The rules of this approach state that the trainer, in his questioning of the team, will direct all questions to the team supervisor. The team supervisor is, in turn, free either to "take the shot himself" or to seek assistance in answering the question from any chosen member or members of the crew.

Besides the stated goals, this technique has other advantages. The trainer can detect under-utilization of valuable team resources, such as the STA, or over-utilization of the strong team members. The trainer can then provide feedback to the supervisor to help improve his resource utilization. It should come as no surprise that the more experienced supervisors take to this technique better than the newer supervisors. In fact, some of the more experienced supervisors will pose additional, followup questions to their team to ensure that an area is solidly covered.

Another technique that has routinely been used is the technique of the team self-critique. In this strategy, the trainer's critique notes are supplied to the supervisor, who reviews and discusses them with the team. This technique stresses accountability for individual actions or mistakes. It is easy for the team to see that individual actions can greatly affect the overall team performance. The self-critique concept can be likened to the idea of reviewing the game film and it has the potential to be an even more powerful tool if a video recording of the performance is available.

An overall evaluation of the team training experience by both trainers and crew members indicates that the initial phases of team training have been successful and that this training has produced observable improvements in operating crew performance as a team. A review of team critiques indicates a definite improvement in the teamwork and diagnostic abilities of the crews during exercises stressing normal and minor off-normal activities, but a possible decline in these skills during increasingly complex abnormal situations. This last observation provides trainers with the continuing challenge of further improving the development of team building and diagnostic skills.

USE OF VIDEO TAPING DURING SIMULATOR TRAINING

Michael Helton
Phillip Young

ABSTRACT

The use of a video camera for training is not a new idea and is used throughout the country for training in such areas as computers, car repair, music and even in such non-technical areas as fishing. Reviewing a taped simulator training session will aid the student in his job performance regardless of the position he holds in his organization. If the student is to be examined on simulator performance, video will aid in this training in many different ways.

INTRODUCTION

Until recently, simulator training was done primarily by instructor to student interface only. The student would perform and/or respond to a casualty and the simulator instructor would critique the evolution. Now the use of a small, self-contained video camera for simulator training has been successfully used at various sites for improving the method of training personnel. The camera critique is effective in improving instructor/student feedback, resulting in more highly skilled, safer operators which are essential to the nuclear power generation industry.

HISTORY

Simulator training for operators begins by performing a plant startup with ascension to 100% power, and then a complete shutdown. This intense training program covers a period of several weeks. During the training sessions, malfunctions (casualties) are introduced beginning with the least severe (i.e. pump trips, failed valves, etc.) and progressing to the most severe (i.e. steamline break, loss of feedwater, etc.). The worst case malfunctions result in implementation of the site Emergency Plan and are normally taught in sessions of approximately 45 minutes to 1.5 hours in duration.

Following each training session, the simulator instructors critique crew and individual student performance. The critique includes, but is not limited to, student verbal response, physical actions taken, sequence of events, what was observed versus what happened, and overall performance.

It is not unusual for the critique to lead to a discussion of whether or not a student actually did as the instructors said or if a problem was overlooked or the session lasts as long as it seemed to the students. Replay or backtrack features of a simulator are sufficient for some types of critiques but they do not show student response or the actual elapsed time of a training session. During final training sessions, a video recording can be used as an invaluable training aid.

USES

Replaying a recorded simulator training session as soon as possible after the session has ended not only reinforces the instructor critique but also allows the student to learn from his errors almost immediately. He can see for himself any needs for improving teamwork, communications, control room manipulations, or any other areas discussed with the instructors. A critique of a training session by viewing a video recording benefits the instructor as well as the student by improving his simulator instruction technique, the quality of student feedback, and instructor to student relations.

Recording mid-course and/or end of course audit exams is another valuable use of the video camera as a training tool, in that it aids the student in improving his performance. The recording indicates his weaknesses in exam-taking technique under stress, points out errors in exam protocol, and enables him to take future exams with greater confidence by helping him overcome these problem areas. The video replay shows weaknesses in performance, poor habits, and mistakes thus allowing both the student and instructor the opportunity to see what really occurred. Usually, the replay emphasizes to the student that the actual elapsed time of the session was much longer than it seemed, and allows the response to certain problems to be thought out. Realization of the "real time" could reduce the chance of making serious mistakes not only in the simulator but, more importantly, in the real control room by showing the operator that sometimes an immediate response is not always the desired response.

A replay can also reinforce an instructor's comments on previous critiques about a student or crew problem, as shown by the following examples:

1. During a taped audit exam, a student is irritated by questioning and constantly evades the examiner. During the critique following the exam, these observations are pointed out to him, and are strongly denied. After reviewing the recording, the student and his crew agree that the examiner's observations were correct. The crew also notes areas of weakness in both individual and team performance. It should be noted that the critique of the video recording may also prove the examiner/instructor to be incorrect in his evaluation.

2. One crew has difficulty developing as a team, i.e. poor communications, poor use of procedures, weak team ability, etc. Following several weeks of training with the instructors attempting to correct the problems, it is decided to use video replay. The video replay fails to help, so another crew, which has developed these skills, is taped. This second crew's tape is shown to the first crew, typically resulting in improving the skills which were lacking before.

EQUIPMENT

Any type of self-contained movie camera with a telephoto function can be used. If a self-contained VHS or Beta movie camera is used, it would allow viewing to be done at home, and avoid tying up valuable training time following the initial viewing.

The new models are relatively inexpensive and usually don't require any special lighting. One problem, however, can be sound quality. Most of the self-contained cameras have an externally mounted microphone. This microphone receives the usual 60-cycle 'hum' from all the electronic equipment in the simulator. Wireless or strategically placed microphones can virtually solve this problem but adds to the expense.

A tripod is not essential but, if used, should be of sturdy construction, simple to use, and compact if availability of storage space is a concern.

Recently, the use of multiple cameras is being tested at some facilities. These cameras are program connected to the simulator computer and respond to malfunctions just as they occur. Again, this is being tested and cost could be a deciding factor.

If multiple, computer driven cameras are not possible, then the use of another instructor, who knows the evoluton, could be used as the camera operator. Knowing the evolution, he is able to direct the camera to the area affected by the malfunction, and eliminate the need to aim the camera before the training session begins. The student is then unable to anticipate the casualty from the direction the camera is pointing.

IV.A.4.5

ADVANTAGES AND DISADVANTAGES

Advantages

1. Shows strengths and weaknesses of students during evolutions.
2. Shows the good as well as the bad habits of the students.
3. Shows student mistakes made during the evolution.
4. Shows any simulator problems affecting the evolution.
5. Reinforces instructor comments made during the training and critique.
6. Allows the student to observe any problems with communications.
7. Gives the student a feel for real time during the evolution.
8. Prevents instructor/student conflict.

Disadvantages

1. Sound quality is somewhat poor due to typical 60-cycle hum.
2. Cost of setup time since the camera cannot be left out at all times.
3. Equipment cost must be considered since budgets are of concern.
4. Camera fright of student while trying to perform during an exam*
5. Availability of non-interfering but effective camera location.

*This could be an advantage by helping the student to overcome the uneasy feeling of being observed.

SUMMARY

Just a few years ago, reactor scrams were commonplace in nuclear plants around the country; but today, as a result of intensive training, it can be seen that the best method for operating a plant safely and reliably is to operate at full load, consistently. We train the operators to operate in this manner, monitor control room parameters, and respond to abnormal situations indicated by these parameters.

Today, we are more aware of how safe, reliable and consistent plant operation is dependent on quality training. Public safety and the financial health of the nuclear industry depends on the training provided.

It is obvious that the advantages by far exceed the disadvantages of improving training techniques to produce a more highly-skilled, competent, and most importantly, a safe plant operator.

The use of video recorded training sessions is and will continue to be a valuable training aid as long as there is a need for well trained operators.

I&C MAINTENANCE TRAINING SIMULATORS

MEETING THE GOALS OF NUCLEAR PLANT TRAINING

Samson Shilmover, Jr.

ABSTRACT

As we examine the goals of training from the point of view of the instructor, student, and employer, we will see that I&C maintenance training simulators meet or exceed those goals.

An instructor's overall goal in I&C training is to impart as much skill and knowledge as possible about the operation, tune up and troubleshooting of a piece of equipment. Through the use of a training simulator, the instructor has the "actual" equipment to demonstrate the principles he is trying to make.

A student's goal in training is to improve his skills by learning as much as possible about the equipment he will be responsible for. When a simulator is used, a student gets hands-on time with the equipment where normal and abnormal conditions can be demonstrated. The students may be asked to perform job-related tasks and be evaluated on their performance.

An employer's goal is to get personnel who can quickly fit into their work force. When training is performed using simulators, the employee receives the knowledge and hands-on skills necessary to quickly fit into the work force. The employee also gains confidence in working with the equipment. Another advantage for the employer is that training can be performed without shutting down the plant equipment. The employer thus can use the trained employees sooner and mainstream them into the work force.

In summary, the use of I&C maintenance simulators can greatly enhance the quality of training and will prove to be beneficial to the instructor, employee, and employer. Although other training methods can meet some of the goals of training, the use of simulators will decrease training time, increase the operational skills of employees, decrease probability of equipment damage due to employee error, and increase employee productivity and safety.

IV.A.5.2

SIMULATOR TRAINING AND SAFETY ISSUES

"Training of personnel who operate and maintain nuclear power facilities is a vital part of the safe operation of these facilities."[1] Assurance that personnel have received the highest possible level of training is one of the highest priorities of any industry where personal or public safety is involved. In those industries where personal and public safety is involved, training simulators are used to assure that personnel receive the quality of training required to guaranty that safety standards are maintained.

The utilization of simulators to meet learning objectives can be one of the best means of assuring that critical skills can be performed safely and in a timely manner. When a training simulator is tied into a course of learning the benefits accrue to all involved in the training process. By examination of the goals of the training process, and what is required to effectively meet these goals, it can be clearly seen that the use of training simulators greatly enhances the training process.

Simulation, while expensive, is regarded as the best - often the only - way to approach some performance training needs. In most cases, the expenses of simulation pay for themselves as soon as a condition arises where it is obvious that training alone was responsible for averting some serious problem. The more closely a simulator resembles the actual equipment, and the responses of that equipment, the greater the benefits will be to the training received. Pilots, at different stages in their training, receive instruction in a simulated aircraft cockpit that looks, feels and reacts like an actual airplane cockpit. The training simulators utilized by the airline industry are normally exact duplicates of the actual equipment connected to a computer for simulated response of the aircraft. This allows abnormal and normal conditions to be evaluated for correct response without the risks of endangering public safety.

In the nuclear industry, control room operators are required to be certified on a simulator prior to taking over control room watches. Many utilities have gone to the expense of duplicating control rooms and require their operators to spend off-shift time performing on the simulator. In this way the utilities are assuring that operators can handle normal and abnormal evaluations without the expense of lost revenues of performing training evaluations on the plant.

ADVANTAGES OF USING SIMULATION IN TRAINING

The advantages of using training simulators in a I&C maintenance training course must be examined from the point of view of the instructor, trainee, and employer. To effectively utilize a simulator in a course, the course must be structured around the use of the simulator. In the I&C training environment this dictates that the maximum time be spent either demonstrating or having the trainee perform on the simulator. Experienced I&C and navy nuclear instructors claim that early career training on a simulator has the following advantages:

1. The trainee is quickly put at ease about working on the equipment;
2. The instructor can get a feel for the pace at which the course of instruction should be geared; and,
3. The enthusiasm of both the trainee and the instructor becomes heightened.

To an instructor, the use of a simulator in a course can be invaluable. Key concepts can be demonstrated or pointed out directly on the simulator thus reducing the amount of time required to "get the point across." Demonstration and performance capability is the major advantage to one-on-one instruction in a course where a simulator is utilized. In a tutorial or small group setting, the simulator instructor can provide practice, can perform formative testing, and can observe tool using skills to decide whether the trainees are ready to move to the next step in their training. The feedback response of observing the trainee, while performing on a simulator, is an invaluable tool. It becomes readily apparent whether the key points where brought across to the trainees by observing their performance while operating or working on the simulator. Course pacing is another advantage of the use of simulators for an instructor. The instructor can develop a feel for "pacing" on a simulator, and can correct performance problems by further review and trainee practice. When trainees satisfactorily demonstrate their abilities to perform specific tasks the training cycle may move on to on-the-job training, classroom, lab, or another simulator setting.

The use of a simulator has numerous advantages to the trainee. First, there is a higher level of enthusiasm for the material to be covered. When a training simulator is tied to a course of learning the trainees become enthusiastic about not only the performance objectives but also the theory of operation of the equipment. This is because adult learners are generally more satisfied when motor skills training and cognitive training are both present in a course. Second, trainees can quickly build confidence in their abilities by the immediate feedback of performing tasks correctly on the simulator. Trainees are required to commit to a course of action and are able to see the responses to their actions. When the trainees see that they can perform successfully on the simulator their confidence that the knowledge and skills obtained on the simulator can be transferred to job related tasks is assured.

In the risk-free environment provided by the training simulator, experiments can be performed and trainees will be able to measure the effects of their actions. This can be a major advantage especially where abnormal evaluations are performed (i.e. troubleshooting and equipment modification). Simulators can help trainees to develop a systematic approach to exploring the cause and effects of abnormal operations of the equipment, and help them establish a basis for evaluation of proper operation.

On-the-job training and classroom training often can take a longer period of time to establish needed skills than does simulator training. Employees, then, are often less productive for a longer period of time.

Down-time of essential equipment can be reduced with simulator training since the employees will be more familiar with the proper operation of the equipment, and be able to isolate faults at a faster rate. Normal evaluation such as equipment alignment and general preventive maintenance will also be performed with greater accuracy and with less down-time of the equipment as a result of simulator training.

CONCLUSION

Simulators are a effective training tools, and their cost should be measured in terms of the consequences of inadequate employee performance.

Some sources estimate that an unplanned outage costs a utility approximately one million dollars a day in lost revenues. The reasons for an unplanned outage are many, and the duration of outages varies widely. To the extent unplanned outages are a result of inadequate training, the decision to use simulation as a method of reducing the number and duration of unplanned outages should be evaluated carefully.

Employees generally respond well to simulation, and expert evaluators can observe not only the level of trainee performance, but whether a trainee exhibits any overt nervousness which may need to be addressed through increased practice or other means.

"No matter how carefully designed or how well the equipment functions, the engineering systems cannot work without people... People are necessary to monitor, correct, adjust and take other actions to maintain the systems."[2] Simulators can be a cost effective tool when used to train employees who perform tasks which are relied upon to keep the plant up and running in a safe and efficient manner.

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INCIDENTAL INSTRUCTOR TRAINING-
DUKE POWER'S ANSWER TO
PREPARE THE OCCASIONAL CLASSROOM
INSTRUCTOR OR VISITING VENDOR

Janet R. Salas, Ph.D.

ABSTRACT

To ensure occasional instructors deliver instruction that is systematically organized Duke Power's Production Training Services has developed an Incidental Instructor Training Package in self-study and group workshop formats. This paper describes the training package, its implementation and results.

INTRODUCTION

At Duke Power, there is a commitment to the Systematic Approach to Instruction. All full time classroom instructors complete a two week, seventy-two-hour Instructor Training course which they must pass before they deliver any classroom instruction. With this program well established, Production Training Services recently tackled another training need - that of the occasional or incidental instructor. Incidental instructors are defined as those plant subject matter experts, visiting vendors, or guest speakers called upon to deliver infrequent or one-time-only training. It is important that trainees in these occasional instructors classrooms receive instruction that is also systematically organized even though most of these instructors probably will not have knowledge of the systematic approach or preparation of performance objectives. In addition, Production Training Services wanted to establish a method to verify ahead of time that any scheduled vendor training did meet training needs and followed the systematic approach to training. With budget constraints most companies face it is vital the vendors selected to provide instruction are required to supply assurance that the training to be delivered does meet training needs, will be effectively delivered, and achieve desired results. To resolve both of these instructional situations, Production Training Services developed Incidental Instructor Training and a key organizational tool - The Incidental Instructor Preparation Plan. This paper will describe the training package developed, how it has been implemented and results to date.

INCIDENTAL INSTRUCTOR TRAINING PACKAGE

Two formats have been designed to serve our three nuclear stations individual needs: a self-study manual and a group working format. The training package also includes a facilitator's guide for conducting individual or group training, a video-tape, exercises to be completed by participants and evaluation forms to allow for participant feedback.

THE INCIDENTAL INSTRUCTOR SELF-STUDY MANUAL

The self-study manual is designed to train an individual who has his/her topic clearly in mind, in four to six hours followed by a de-briefing with a trained facilitator. The facilitator is close by to answer questions any time during training but is especially important during the de-briefing when he/she evaluates the end product - The Incidental Instructor Preparation Plan - prepared by the participant - and offers clarification, guidance, and suggestions for improvement.

THE INCIDENTAL INSTRUCTOR GROUP WORKSHOP

The Incidental Instructor Lesson Plan allows a trained facilitator to train eight (8) participants in approximately six (6) hours. Using interactive discussion, a videotape and exercises the facilitator guides participants through stages of learning, effective use of motivation, language, and questioning techniques. When all participants have completed an Incidental Instructor Preparation Plan each participant briefly gives an overview to the group of (1) how the information or task will be taught, (2) training aids that will be used, (3) questions to be asked and (4) points to be watched for to assess trainee's learning. The group gives feedback to the Incidental Instructor on clarity, logic of sequence, appropriateness of terminology, training aids, pace of training, and any crucial delivery problems that may be noted. The facilitator covers any content or presentation problems the group may have overlooked. At the end of the session, the facilitator collects the Incidental Instructor Preparation Plans for more thorough evaluation. The reviewed plans are returned in a day or so with more detailed comments that may have been missed or were not appropriate to share with the entire group. After each training session (Group Workshop or Self-Study) conducted facilitators return participant feedback evaluation sheets to Production Training Services. This information is assessed to determine how the training is being received and areas where it may need to be improved or revised.

THE INCIDENTAL INSTRUCTOR PREPARATION PLAN

This five page worksheet was developed to help an incidental instructor with no previous knowledge of effective systematic training prepare an organized classroom presentation. The plan brings to mind important items an inexperienced instructor needs to consider including (1) attention to purpose, (2) motivating introduction, (3) sequence of points to be discussed, (4) development of training aids, and (5) effective summary. To reinforce training a handout containing guidelines to review just prior to teaching is also included to remind the occasional instructor of items to remember to do before the presentation, during the presentation and after the presentation.

Attached to the plan is a suggested letter format which can be sent to vendors (or guest speakers). Items suggested to be covered in the letter include:

- an outline of expectations of the vendor/guest speaker
- a list of objectives the vendor/guest speaker needs to cover in his/her presentation

- available time for the presentation
- training materials/audio/visual equipment available for the vendor's use
- date, prior to training, vendor must submit objectives, lesson plan, materials for review, approval or possible revision

FACILITATOR TRAINING

Facilitator who deliver the Incidental Instructor training have completed a seventy-two (72) hour Instructor Training course or a similar course and a three (3) hour Incidental Instructor facilitator training program which trains participants to use the entire training package.

INCIDENTAL INSTRUCTOR RESULTS

The Incidental Instructor Training program was implemented July 1, 1986. To date, seven (7) facilitators and fifty-five (55) Duke Power occasional instructors have been trained. The feedback from participants has been extremely positive. Incidental Instructors feel more organized, prepared, and confident. They particularly appreciate the guidance the facilitators offer. As one participant said, "I feel better about instructing a group now than I did before."

Recently, facilitators met to talk about training effectiveness and the need for changes and additions. This feedback from facilitators plus comments from participants indicates a need to increase emphasis on delivery and practice.

The Incidental Instructor Training is off to a successful start. The next few years promise more efficient and effective occasional instruction delivered by Duke employees as well as contacted vendors. The payoff will be in the results:

1. Training which produces more competently trained, satisfied workers.
2. The best use of our training dollars.

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"BRINGING IT HOME"

MAKING NUCLEAR POWER PLANT TRAINING RELEVANT

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ABSTRACT

In 1985, a new series of multi-image training modules was created for the Pilgrim Nuclear Power Station's General Employee Training (GET) program. In the year since its initial delivery, the multi-image component of GET has been highly praised by both Boston Edison management and INPO. Most importantly, the multi-image modules, along with a newly implemented curriculum have increased the effectiveness of GET at Pilgrim.

INTRODUCTION

General Employee Training (GET) is a requirement that often strikes fear and trepidation in the hearts of nuclear power plant employees. It usually means having to sit through one or two days of boring lectures about things which they already know as well as they know the backs of their hands.

GET also strikes fear in the hearts of nuclear power station instructors, as they present the same information, day after day, in such a manner as to not bore their trainees, meet the requirements of the NRC & INPO, and just maybe have their trainees learn something. And, during an outage, when it becomes absolutely necessary to run the trainees through GET efficiently, the instructors need to be able to do their job without suffering burnout.

One of the solutions to this problem is the use of videotape training materials that are abundantly available. In the past, Pilgrim had bought and used several of them, but because generic videotapes never quite met our requirements, a nearly equal amount of class time needed to be spent explaining the difference between the tape and the way it was done at the plant.

This was the case at the Pilgrim Nuclear Power Station, in Plymouth, Massachusetts, prior to 1985. Having just completed a 2-year outage, our training staff had gone beyond burnout almost all the way to meltdown. We wanted something to spice up and improve training, while keeping the attention of old employees, and effectively communicating important information to new employees. Most importantly, we wanted tools to use in instruction, not just a media piece to replace the instructors. We wanted media to meet the instructional objectives of our new curriculum without compromise. And, we wanted the ability to easily and quickly update our program when changes occurred in plant operation or facilities.

MULTI-IMAGE

First, a word about the medium known as Multi-Image. Most people think of it as nothing more than a fancy slide show. While it's true that Multi-Image uses slides for visual content, we've found that it is more than just a slide show!

Technically, Multi-Image uses slide projectors controlled by a computer. The computer receives its information from a separate data track on the audio tape. It decodes the data into instructions for the projectors, causing them to show the right slide at precisely the right instant (with up to .01 second accuracy), and to smoothly change from one slide to the next (from an instant "cut" to a 99-second dissolve, or anywhere in between). The projectors may be concentrated onto a single screen for a maximum of slide change speed and image complexity (as we use at Pilgrim), or they may be spread out in a wide-screen format for a panoramic effect. It's even possible to control 16mm film, lights, or other special effects devices, in addition to the slide projectors.

Multi-Image hardware has made quantum leaps in technology as computers have become more sophisticated and less expensive. Current state-of-the-art equipment gives the medium the same random access capabilities as videotape, and also makes it virtually impossible (barring mechanical failure of the projectors) for the slides to go out of sync.

But, with video so convenient to use, why did we decide to go with a multi-image format? The answers are fourfold:

1. Image quality:

   Our GET classes average 30 people, in a comfortably large training room. For adequate visibility by everyone, our image size is about 6-feet across. We are currently using our video projector with VHS tapes for certain modules, but there is absolutely no comparison in quality. In fact, the BEST videotape machine can only reproduce 525 lines from top to bottom of the screen. VHS or Beta machines are far worse, so if this is blown up to a big screen, the raster lines, color-shifts, and misalignment from a 3-tube video projector, become rather obvious. By contrast, the resolution of a typical slide measures over 4000 lines, and there is never any electronic distortion.

   High Resolution videotape formats are currently under development, but their introduction is still years away. And, when they are introduced, high-resolution video projectors will be cost prohibitive for most utilities. Even when high-resolution video is available, it will still suffer from the other drawbacks of video.

2. Flexibility:

   With a videotape, what's on the tape is on the tape. It cannot be changed. With a properly designed Multi-Image program, minor updates are easy . . . just shoot a new slide and drop it in! But not all multi-image shows are obsolete-proof. Our producer was careful to note which information may be changed during the life of a show and keep the specifics out of the soundtrack but presented on the screen. Then, when the specific item changes, a new slide can be dropped in . . . no special training necessary.

   Sometimes, however, audio changes are inevitable. With one of our programs, a change was necessary in the soundtrack just weeks after it was delivered. Because the sound and visuals are separate, it was very easy, and cost efficient, for Advent/Nuclear to re-do the soundtrack and bring us a new tape. The tape even changed the sequencing of the slides for the edited portion, without having to move them all. It was an easy, convenient, no-compromise way to keep our show current.

3. Transferability:

Even though a Multi-Image show looks best projected on the screen, it can also be transferred to either videotape or 16mm film. These other formats offer the option of off-site GET classes, or, conducting small classes without tying up the large classroom. However, if any slides are changed, new transfers must be made.

4. Production Convenience:

Photography in a nuclear power plant is a difficult undertaking. Bringing in a large amount of equipment to adequately shoot videotape or film is not only a touchy security issue, but it also is a risk for the production crew as thousands of dollars worth of equipment could be contaminated. And, lights and cameras can cause a major interruption in work for employees. Photography with Multi-Image is done with a professional 35mm still camera and flash combination. Photography can be done, even in contaminated areas, with little risk to the photographer or equipment. And, since a minimum of equipment is used, disruption of daily work is minimized.

For our program, a six-projector single-screen format was chosen to maximize the screen impact within the given equipment budget. The training room was already equipped with a rear-projection booth and screen to which the system was adapted.

One of the benefits of today's Multi-Image systems is the availability of equipment. While Advent/Nuclear was very specific about our equipment needs, we were able to purchase our system from a local AV dealer. The local dealer provides prompt technical support, which includes supplying backup units should anything break down. In a year and a half of use, the only technical problems encountered have been an occasional burned out projector lamp and dirty tape heads.

PILGRIM STATION GET PROGRAM SUMMARY

In 1985, we had completed revising our curriculum for GET, and we wished to produce media to help us teach it. One key element was that we wanted media to SUPPLEMENT our teaching, not to replace it. After much consideration, we chose Multi-Image. To fit our budget needs, we took delivery of our first three modules in 1985:

1) Industrial Safety,
2) Radiation Protection Overview, and
3) Boiling Water Reactor (Plant Familiarization).

In 1986, we ordered three additional modules:

1) Quality Assurance,
2) Respiratory Protection, and
3) Biological Effects of Radiation Exposure.

(These last three have just been delivered after a prolonged production period caused by a strike that hit our plant last summer.)

One of the very unusual ways chosen to treat the topics was to relate tasks our workers perform at Pilgrim Station to tasks they perform at home. Some of the analogies entertain and use humor to teach. Others really make the subjects "click". Here's a short rundown on what we have:

Theme:

All the modules have one common theme running throughout: DO IT RIGHT!. This includes a common graphic treatment as well as a music string that fits. Advent/Nuclear discerned that this was the overriding message we wanted our workers to understand. If you're going to work here, do it right!

Boiling Water Reactor:

For part of the "Plant Familiarization" segment of GET, a module on how a Boiling Water Reactor works was created. With extensive use of the slide animation capabilities of Multi-Image, we show neutron absorption, fission, the chain reaction, thermalization of neutrons, and water flow through a BWR. The amount of energy we produce is related to numbers of coal cars, volumes of natural gas, and "six-million, seven hundred thousand 100-watt light bulbs."

Industrial Safety:

A film on Industrial Safety has the tendency to be a "do this" and "do that" for things already well known. To improve on that approach, we chose to highlight three major safety themes: Safe Attitudes, Safe Conditions, and Safe Practices. Instead of continuously lecturing on these themes, several humorous scenarios are acted out, including someone tripping over an open file drawer while not paying attention, someone banging his head without a hardhat, and someone coming to work with a hangover, thus encouraging trainees to be "mentally fit for work."

Radiation Protection Overview:

This was a real challenge. In 20-minutes we asked to have ALL the radiation safety instructional objectives normally taught in about 6 hours of classroom instruction capsulized. We wished to use it as a review of the regular instruction, just before giving the employees the test. Since delivery, we have also found it invaluable for requalification training. It serves as an ideal refresher for people who have already had the training and who work with radiation everyday.

Even with this usually new topic, we make it relate to the worker's everyday life. For instance, the module begins with a comparison of familiar radiations such as sound and sunshine, and relates how these can be found to be pleasant, and how they can also be harmful if their intensities are too great.

Quality Assurance:

Quality Assurance also posed a challenge, since it is a concept which can be difficult to communicate. We chose to meet this challenge by relating quality assurance to things people do everyday - from buying a car to fixing a home toilet. Then, the show covers and summarizes the 18 criteria of Quality Assurance mandated by 10CFR50 Appendix B, and graphically shows how the criteria interrelate and are actually used in everyday life, even though we don't quantify and record that we have completed them.

Respiratory Protection:

This module is designed for Level 2 workers who may use respiratory protection devices. It covers the reasons for using respiratory protection, and the exact procedures for checking out, inspecting, wearing, removing, and returning the full face mask respirators used at Pilgrim Station. While not too many analogies are used, the beginning highlights many of the warning signs of airborne contamination that workers need to be aware of.

Biological Effects:

This module is used to enhance one of the eight Radiation Protection modules taught at Pilgrim Station. It spends its 20 minutes relating the health-physics concepts of biological effects in a very understandable manner. Included are the energy of a millirem, acute effects, chronic effects, and the linear and threshold theories, all related to the risk of getting wet from exposure in a rainstorm. The chances of health effects from exposure are compared to one's chances of winning the lottery, bringing this fairly complex topic down to some simple common denominators.

PRODUCTION TECHNIQUE

Advent/Nuclear's approach to multi-image production is unique. From our observations few media producers use this technique to assure client satisfaction from the start. It's a Quality Assurance program for media!

They begin by reviewing the plant's training objectives with the training staff - just what we want to teach in each module. In the ensuing discussions, they make recommendations relative to what objectives may be handled best with multi-image, other media, or lecture.

Following this review and discussion with plant personnel, a Treatment is developed. The treatment is a glorified outline, describing just how they propose to "treat" the objectives selected, not only in the module in question, but also relative to the entire GET program. It includes pieces of script and ideas for visualization, transitions, and music. It's in this stage that everything is flexible. Without wasting a lot of time, we can see which ideas fly and which ones don't.

The Treatment is presented to the training staff for our approval. Our policy is to have the treatment reviewed by the appropriate subject matter experts in the plant. Since it is only on paper, anything can be changed at this point, and usually, a lively discussion results in a revised treatment that fully meets everyone's expectations.

From the Treatment a visualized Script is written, in the traditional format of visuals on the left and audio on the right. This is a collaborative effort between Advent/Nuclear's technical experts and script writers, and plant personnel, to assure all the audio and visual components will be authentic and correct.

The script is then sent to plant subject matter experts for review and for approval. Since it has been written in such a cooperative manner, and based on the already-approved treatment, major changes are rarely encountered.

From the script, the "Shot List" is prepared. This is sent to us, and we work to set up the appropriate shots, scheduling plant personnel to serve as models. A large number of plant personnel are used on screen to humanize the final product. The shooting schedule is finalized before photographers arrive on site.

Outdoor scenes that relate the local plant environs to the program are also used, sometimes shot from the air. Both utility line helicopters and private aircraft have been used for these shots.

A number of scenes also are shot in Advent/Nuclear's Northwest Columbus studio or around Central Ohio. These are generic scenes that do not require specific plant photography, but very effectively illustrate the objectives to be taught.

Meanwhile, Advent/Nuclear's artists work on creating the graphics for the show. These provide vividly colored animated graphics that simulate movement with still image technology.

Also, the recording engineer receives the script and begins to lay down a rough soundtrack in Advent/Nuclear's recording studio. Music from their music library is selected, and often voices and sound effects recorded on site are added for complete authenticity. We are asked to approve music and voice selections.

Once the photographers return from the plant with photography, and the graphics and rough soundtrack are completed, assembly begins. The slides are cataloged, then sequenced with the script. A computer is used to program the slide changes, using a technique similar to the SMPTE time code commonly used in video production.

After the rough program is completed, a videotape "screen transfer" is made and sent to us. We can thus preview it at our convenience. We usually telephone our comments to the production team and they begin the "polishing" phase, where timing, image, and audio adjustments are made.

After polishing is complete, the show is duplicated. The originals stay in Columbus, and the duplicate is prepared and delivered to the plant site. The Advent/Nuclear people take our training staff through the operation of the show, making sure we understand how to screen it successfully. We were also left with thorough written instructions.

Advent/Nuclear keeps the originals for several reasons: First, if something happens as it is shipped to the plant, the original slides are not lost. Second, if something should happen to our slides, Advent/Nuclear can quickly duplicate a new set and send out the needed replacements. Thirdly, when the time comes for revisions, Advent/Nuclear revises the originals, and sends the updates to us, so we never have down-time while a show is revised.

RESULTS

The results of the Multi-Image training materials at Pilgrim Station have been very gratifying. The most noticeable effect is a significant increase in attention span from our trainees, thanks to the freshness of the media. Seeing themselves or other workers they know on the screen also contributes to a positive attitude toward the training sessions by the employees.

The most recent INPO review of GET at Pilgrim praised the Multi-Image portions without criticism, and commented "(the Multi-Image) component is indicative of a strong commitment to general employee training in radiological protection."

In summary, we are very satisfied with Multi-Image as a way of supplementing our training efforts. Advent/Nuclear's expertise and creativity have succeeded in helping us make our General Employee Training unique.

PRESENTATION

Our presentation will include a screening of several segments from the Pilgrim Station GET program to illustrate how we use everyday examples to relate plant requirements to the trainees.

PROPOSED COMBINATION OF TRAINING AND EDUCATION TO MEET THE BACHELOR OF SCIENCE REQUIREMENTS

Albert E. Wilson

ABSTRACT

The basic similarities and differences of the education and training which, in the author's opinion, are actually needed by reactor operators are outlined and compared with the NRC requirements. Examples of engineering degree programs are presented to demonstrate that they are NOT the appropriate educational goal for a senior reactor operator. A possible program of study which could be implemented jointly by a utility and a nearby college or university is presented. The program combines both education and training to complete the requirements for a bachelors degree. Those student-operators entering the program should be able to work as auxiliary operators while pursuing the degree part time and qualify for the NRC Reactor Operator exam in five years. Then, while working as RO's, they should complete the degree requirements in another year. After an additional year of RO experience, they should meet the NRC requirements for Senior Operator.

Finally, some of the possible pitfalls of such a program are discussed. These include such things as drop-outs, union agreements, inflexibility of educational institutions and, of course, cost.

INTRODUCTION

All of the utilities operating nuclear power plants have improved their training programs for plant personnel and most, if not all, of these training programs meet the standards of the Institute of Nuclear Power Operations (INPO). However, none of them will meet the guidelines of the Accreditation Board for Engineering and Technology (ABET) for accreditation as engineering degree programs. The goals of INPO and ABET are vastly different and it would be virtually impossible to meet the accreditation requirements of both with a single program. ABET considers engineering to be a "design profession", as do most engineering educators. The ABET criteria are not the same as those of INPO. A recent ABET publication[1] stated:

> These criteria are intended to assure an adequate foundation in science, the humanities and the social sciences, engineering sciences and engineering design methods, as well as preparation in a higher engineering specialization appropriate to the challenge presented by today's complex and difficult problems.

If it were not for the mind set of some of the people in the Nuclear Regulatory Commission (NRC) that an engineering degree in the control room will solve all their problems, we could probably dismiss the engineering degree as inappropriate just on the basis of the above accreditation criteria.

If education is important, and it surely is, then we should develop appropriate educational programs and convince the NRC that they are, indeed, appropriate. Also, if the educational program is equivalent to one leading to a bachelor of science degree, then a degree should certainly be awarded at the end of the program. One such possible program is presented at the end of this paper.

PROGRAM IMPLEMENTATION

In order to implement a training/education program at a nuclear power plant which will lead to an acceptable bachelor of science degree, you will most certainly have to work closely with a nearby college or university. It will require some changes in attitude of the leaders at both the utility and the educational institution to make such a program work. For example, most educators don't believe that learning to do a job well is "education" while most utility managers probably don't understand why the plant operator should have an appreciation of music. (The operators themselves probably don't understand that either.) However, knowing how to do a job well is important to the plant and having a broad education is a requirement for the degree.

It will help a great deal in working out a suitable program if you have someone at the plant who has had considerable experience in a college or university, preferably in an administrative capacity. You need someone who speaks the right language. For example, colleges generally do not grant academic credit for "on-the-job training". However, there are many programs, such as nursing and education, which require, and grant credit for, a "practicum". Webster[2] defines "practicum" as

> A course of study designed especially for preparation of teachers and clinicians that involves the supervised practical application of previously studied theory.

So make sure you treat your operators as "clinicians" and always say "practicum" and not "OJT".

The instructors which you use in the program are also going to have to be approved by the college. I don't know how it became established that doing some (usually useless) independent research and publishing the results in some (usually obsure) scientific journal was a necessary requirement for teaching courses which carry college credit but that is a "fact" which you will have to consider.

The above examples may seem a bit facetious but, in all seriousness if you are asking an educational institution to grant their degree for your program, your program has to, somehow, be made to fit their mold.

THE PROGRAM

The curriculum for one possible program is given in an Appendix to this paper. I have called the degree "BS in the Physics of Reactor Operation" but you must recognize that there are usually political implications to any new degree. Early in the planning, a Task Force of leaders from both the Local State College (LSC) and the Nuclear Power Plant (NPP) should be formed to work out potential problems. A few of the potential problems which this Task Force may need to resolve, in addition to the name of the degree, are given below.

Curriculum

The possible curriculum given in the Appendix is a very rough outline of what might be appropriate. The courses will have to be carefully screened by the Task Force or an academic advisory committee established for that purpose. New courses will almost certainly have to be approved by the Curriculum Committee of the LSC.

Faculty

The NPP will have to hire faculty who meet, or exceed, the minimum requirements of the LSC to teach the special courses. These persons, while employees of the utility, will require adjunct appointment at the LSC.

Course Scheduling

Scheduling of courses at the NPP presents a particular problem if the student-operators are working a rotating shift. Assuming a six crew rotation, it should be possible for all students to attend a class which is taught twice during the same day: once from 0800 to 1100 and again from 1245 to 1545. The day crew and relief crew could trade off, the training week crew could attend either, the swing crew could come in early, and the mids crew could stay late. Anyone with that day off would have to come in for one session or the other. Two such courses, perhaps one on Tuesday and one on Thursday, would fit the schedule in the Appendix. Each course would meet 17 times for three credits.

Costs

The program is going to be expensive. How you work out the details of possible compensation for back shift employees attending day classes and those coming in on a day off will depend on your particular personnel policies. Also, any regular LSC faculty who teach at the plant should probably be given extra compensation unless the college counts it as part of their regular teaching load. There will also have to be extra operators in the program, at least six, to accommodate the semester on campus and, of course, the NPP must hire special faculty for part of the program.

Retention in the Program

Serious thought needs to be given to the question of retention. What happens when someone gets part way through the program and fails a course? How many times can he fail before he is dropped from the program? What happens if one quits the program? Questions such as these need to be answered by the Task Force before the program is implemented.

Other

There are a host of other questions which must be answered early in the planning process. A few of the questions which will face the Task Force are:

How do you fit in the Requal program for operators? How does someone with previous experience "test-out" of part of the program? What about vacations? How can work be made up if a student is sick? How does an operator get in his control room time during the campus semester? What transfer credit will be accepted? What if a regular college student wants to take one of the NPP courses?

The specific answers to these and other questions will depend on the particular Nuclear Power Plant and Local State College. I don't feel that any of the problems are insurmountable, however, provided the following three conditions are met:

(1) The utility believes that it is in their best interest to have degreed operators and is ready and willing to pay the bill.

(2) The Local State College sees the program as important to their mission of filling the educational needs of the region. (And they might make money from the program.)

(3) The operators really want an education and a degree and are willing to work for it.

CONCLUSIONS

Maybe some of you have tried such a program. I know that several have similar cooperative programs set up at the associate degree level. I don't know of one at the bachelors degree level. I'm not even sure it can be done. However, if such a program can be implemented, I think it will lead to a higher knowledge level for your senior operators, increased job satisfaction for the operators in general, and more stable operating crews.

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IV.B.1.7

APPENDIX A

POSSIBLE CURRICULUM FOR THE PHYSICS OF REACTOR OPERATION DEGREE

YEAR ONE

Fall (NPP)

Present Auxiliary Operator Training Program and initial qualifications. Should also include remedial math and other academics as required.

Spring (LSC)

First semester at LSC

English Composition	3 cr.
Speech	3 cr.
Algebra and Trig	5 cr.
Chemistry	5 cr.
TOTAL	16 cr.

Summer (NNP)

Analytical Geometry	3 cr.

YEAR TWO

Fall (NPP)

Calculus I	3 cr.
Classical Physics (mechanics)	3 cr.
Practicum for Turbin Bldg.	5 cr.
TOTAL	11 cr.

Spring (NPP)

Calculus II	3 cr.
Classical Physics (electricity)	3 cr.
Practicum for Reactor Bldg	5 cr.
TOTAL	11 cr.

Summer (NNP)

Classical Physics (heat, light & sound)	3 cr.

YEAR THREE

Fall (NPP)

Atomic and Nuclear Phys	3 cr.
Electricity	3 cr.
Practicum	5 cr.
TOTAL	11 cr.

Spring (NPP)

Nuclear Reactor Physics	3 cr.
Fluid Mechanics	3 cr.
Practicum	5 cr.
TOTAL	11 cr.

Summer (NPP)

Heat Transfer	3 cr.

YEAR FOUR

Fall (NPP)

Reactor Dynamics	3 cr.
Radiation Chemistry	3 cr.
Practicum	5 cr.
TOTAL	11 cr.

Spring (NPP)

Reactor Control	3 cr.
Radiation Protection	3 cr.
Practicum	5 cr.
TOTAL	11 cr.

Summer (NPP)

Mitigating Core Damage	3 cr.

YEAR FIVE

Fall (NPP)

Control Room Time Practicum	5 cr.
Training Reactor Week	1 cr.
TOTAL	6 cr.

Spring (NPP)

Control Room Time Practicum	5 cr.
Simulator Training	3 cr.
TOTAL	8 cr.

Summer (NPP)

NRC Reactor Operator Exam	0 cr.

YEAR SIX

Fall (NPP)

Computer Programming	3 cr.
Personnel Mgt. & Supervision	3 cr
Practicum	5 cr.
TOTAL	11 cr.

Spring (LSC)

Second Semester at LSC to complete the general education requirements	15 cr.
TOTAL	15 cr.

A UNIVERSITY-INDUSTRY CONSORTIUM: MAXIMIZING THE USE OF LIMITED RESOURCES FOR INSTRUCTOR TRAINING

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ABSTRACT

What. This proposed development effort would accomplish three major objectives, as follows:

1. To identify and verify, through job analysis, the critical professional tasks that must be performed by electric utility instructors.

2. To adapt and revise existing instructor training modules to make them self-contained and highly specific to the professional knowledge and skills needed by electric utility instructors.

3. To develop new instructor training modules, if needed, to meet utility instructor training needs that are not addressed by any existing materials.

How. It is anticipated that approximately twenty (20) modules will be needed to address all of the critical instructor tasks identified during the job analysis phase. The National Center for Research in Vocational Education proposes that it would be very cost-effective and time-efficient to cooperatively undertake the development of the needed instructor training modules with a consortium of about to ten interested electric utility companies.

On November 1, 1986, six electric power companies and the National Center for Research in Vocational Education at The Ohio State University organized the Electric Utility Instructor Training Consortium. The companies giving leadership to and sponsoring Phase I of the Consortium included: Cleveland Electric, Detroit Edison, Duke Power, South Carolina Electric and Gas, Tennessee Valley Authority, and Virginia Power.

The purpose of the Consortium is to achieve three major objectives designed to develop and upgrade the professional skills of new and continuing instructors within the industry. The three objectives are as follows:

- Identify the critical professional tasks that must be performed by electric utility instructors by using job analysis
- Adapt and revise existing instructor training modules to make them highly specific to the professional skills and knowledge needed by electric utility instructors
- Develop new instructor training modules to meet training needs that are not addressed in existing materials

WHY A CONSORTIUM

High-quality employee training programs are essential to the safe, reliable, and efficient production of electric power. However, such training is only as effective as the instructor conducting it. "Training the trainer" is therefore an activity essential to any company's employee training efforts.

The Electric Utility Instructor Training Consortium provides a cost-effective method for preparing training materials that support the development and the improvement of the skills of new and continuing instructors. Sharing the cost of materials development through a consortium allows individual companies to receive greater benefits than they could afford working alone.

HOW DOES THE CONSORTIUM OPERATE

The consortium is directed by a board represented by one member per company. Upon joining and financially supporting the consortium, each company has an equal voice in setting policy and providing input into work activities. Staff from member companies serve as technical consultants in the development of materials, and also review all materials to ensure their accuracy and relevance to the electric utility work environment.

The Consortium staff at the National Center manage the work activities and are responsible for conducting job analysis, task analysis, task verification, and module conceptualization, development, revision, and publication.

Funding to support Consortium activities comes from membership fees paid to the National Center. The fees support work authorized by terms of the membership contract and in accordance with the policies established by the Board of Members.

IV.B.2.4

The current Consortium scope of work consists of two phases. Phase I, the initial job and task analysis, task verification, and task clustering for module development, took place during the period November 1, 1986--February 28, 1987. Phase II, involving the materials development, field review, revision, and publication began March 1, 1987, and will continue through June of 1988, at which time, 20 modules will have been developed.

Work on Phase I began in earnest on November 12-15, 1986, when eleven representatives of the six member companies convened at the National Center in Columbus for the Electric Utility Instructor DACUM Workshop. For those of you who may be unfamiliar with DACUM (Developing A Curriculum), it is simply a structured, small group, modified brainstorming type of process for conducting a very high-quality job analysis of any occupation in a short period of time at low cost. The National Center has used the DACUM process extensively since 1980 in its own curriculum development efforts and has conducted over 100 workshops for various industry, business, governmental, and educational agencies.

The DACUM committee was selected by asking each member company to provide two of their most expert instructors. To provide fair representation of all aspects of instruction, the Consortium Board specified that the experts were to be identified by stratifying the committee around five specialities: (1) classroom instructor, (2) shop/lab instructor, (3) OJT instructor, (4) simulator instructor, and (5) instructional development specialist. At least two persons were selected to represent each of these specialities.

Under the leadership of two National Center experienced DACUM facilitators, the committee worked hard for four days to identify all of the duties and tasks they believed to be important to the instructor's job. Before reaching closure on the fourth day, the committee was asked to review three literature-based task lists[1] to help insure that no important tasks were overlooked.

A few tasks were added as a result of this procedure but mostly the committee felt reassured that they had indeed done a thorough and high-quality job. When closure was reached, the committee had identified 130 tasks clustered into 12 duty areas. The duty areas include:

A. Develop and Maintain Technical Proficiency
B. Develop and Maintain Instructional Proficiency
C. Assess Training Needs
D. Develop/Revise Instructional Material
E. Prepare for Instruction
F. Coordinate and Schedule Training
G. Operate and Maintain Instruction Equipment
H. Deliver Instruction
I. Supervise Trainees
J. Evaluate Trainees
K. Evaluate Training Effectiveness
L. Perform Administrative Activities

The next task was to develop a verification instrument for submitting the tasks identified by the DACUM committee by mail to five to ten instructors in 13 electric power companies. The instrument was submitted to all member companies and to several other companies who indicated an interest in Phase II and a willingness to participate in the verification procedure.

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[1] The literature-based task lists included the Region I generic instructor task list assembled in 1986, the INPO Instructor Job Survey compiled in 1986, and the Pennsylvania Power and Light task list for simulator instructor developed by Janice Reitmeyer.

The verification respondents were asked to rate each task statement on (1) the importance of the task, (2) task learning difficulty, and (3) frequency with which the task is likely to be performed, using a six-point Likert scale ranging from 0-5. A total of 120 instructors, employed by 13 electric power companies and who worked at 19 different plants, responded to the survey by the initial cutoff date.

In addition to the questions asked about each task, questions were also asked about such items as:

(1) Number of instructors employed by the company
(2) Number of years served as an instructor
(3) Occupational area of assignment
(4) Type of instructor training received
(5) Adequacy of the training received
(6) Worker traits and attitudes most important to being a successful instructor
(7) Type of training materials most valuable for new instructors
(8) References found to be most valuable in their job

A report entitled Summary of Task Verification Data: 1987 Electric Utility Instructor Survey was prepared and submitted to member companies and to the Institute of Nuclear Power Operations (INPO).

As of this writing, the 130 tasks have been verified as important and have been tentatively clustered for module development purposes. A significant number of additional electric power companies has also shown considerable interest in possibly joining the Consortium for the Phase II development effort. A report on the current status of membership will be provided at the time this activity is reported on at the Orlando April 1987 meeting.

BENEFITS OF THE CONSORTIUM

The benefits of developing instructional materials cooperatively are many:

- Each company receives 20 modules specific to its instructor training needs, yet pays the cost for only 2 modules.
- By sharing development expertise, the National Center and member companies produce higher quality materials than could be produced alone.
- Use of the resulting, industry-specific modules will help companies produce more qualified instructors, which leads to more qualified employees.
- Companies will be better able to meet accrediation standards for industry instructor training programs.
- Company personnel participating in the module development process will grow professionally when they discuss common problems and solutions with their counterparts from other companies.

WHAT IS THE NATIONAL CENTER

Since many of you are unfamiliar with your National Center for Research in Vocational Education, I hope you'll permit me to describe the organization and its purposes briefly. The National Center is a full-service, non-profit, research, development, training, and information systems organization located at The Ohio State University. In operation since 1965, the organization was officially designated the National Center for Research in Vocational Education in 1978 by the U.S. Department of Education based on a successful but very competitive bidding process.

The National Center's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Providing information for national planning and policy
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

The National Center ensures high-quality service in this effort by combining its over 20 years of experience in developing performance-based curriculum for teachers and educational administrators with its 10 years of consortia leadership. Six consortia with over 70 members presently operate under National Center leadership to provide a range of services to members. The organization is in a unique position to be able to develop high-quality performance based materials for the electric utility industry because it:

- Has had extensive and very successful experience in developing 132 performance-based teacher education (PBTE) modules designed specifically for the preservice and inservice education of vocational teachers.

- Has had extensive and very successful experience in working with 14 state departments of education since 1978 through a consortium arrangement to develop 34 competency-based modules and 11 guides for vocational administrators.
- Is responsible for the National Center Clearinghouse, as well as the ERIC Clearinghouse on Adult, Career, and Vocational Education.
- Operates the National Academy for Vocational Education, which has conducted over 600 workshops and conferences on a wide range of topics.
- Employs a highly professional staff that is experienced in many fields, including business, industry, and labor; and in the development of performance-based training materials.
- Has successfully managed over 900 contracts including over 25 contracts with various companies in its 21 years of existence.
- Has the world's largest library of materials on all phases of career development, preparation, and advancement.
- Is an integral part of The Ohio State University and can readily access its extensive human and material resources.

JOB RELEVANCE OF ENGINEERING AND SPECIALIZED EDUCATIONAL PROGRAMS FOR LICENSED REACTOR OPERATORS

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ABSTRACT

This study investigates the extent to which traditional baccalaureate engineering degree programs and specialized educational programs for reactor operators cover academic knowledge needed for licensed operator job functions. Academic knowledge items identified by a job analysis were systematically compared to the curricula of a sample of the educational programs. Approximately 65% of the academic knowledge identified as necessary for the positions of RO and SRO is taught in college level engineering courses. College engineering curriculum provides considerable material beyond that identified as necessary for licensed operators. There is a great deal of variation among specialized programs for reactor operators, ranging from coverage of 15% to 65% of job-related academic knowledge. Half of the schools cover at least 50%, and half cover less than 30% of this knowledge content.

INTRODUCTION

This paper analyzes the job relevance of (1) accredited baccalaureate engineering degree programs, and (2) specialized college credit educational programs designed for licensed nuclear reactor operators. The purpose of these studies[1,2], carried out for the U.S. Nuclear Regulatory Commission, was to determine the extent to which existing educational programs covered academic material necessary for carrying out the job functions of nuclear reactor operators.

Academic knowledge identified by a job analysis prepared for the Institute of Nuclear Power Operations (INPO) as necessary for reactor operator functions was systematically compared with the content of curricula of baccalaureate degree engineering programs and with tailored educational programs for reactor operators. The INPO job analysis identified over 200 knowledge categories (e.g., division) across 12 major subject areas: Mathematics, Electrical Science, Chemistry, Materials, Classical Physics, Nuclear Physics, Reactor Theory, Instrumentation and Control, Reactor Plant Protection, Health Physics, Heat Transfer and Fluid Flow, and Engineering Drawing.

Subject matter experts (SMEs) in engineering curriculum and nuclear operations training carried out the comparison task to identify the coverage of job-related academic knowledge by the various programs. Eight engineering schools offering B.S. degrees in mechanical, electrical, chemical, and nuclear engineering and eight schools offering tailored educational programs for reactor operators including non-degree, A.S. degree, and B.S. degree programs made up the sample of programs studied.

For the traditional engineering B.S. degree programs, the SMEs indicated whether or not a particular academic knowledge item was covered, and if covered, at what level: (1) a high school level prerequisite to entrance, (2) in the first two years of the core curriculum, or (3) in required upper division major courses. For the specialized educational programs the SMEs indicated whether or not each knowledge item was (1) a prerequisite to the program, (2) covered by the program curriculum.

Extent of Job-Relevant Knowledge Covered by
B.S. Engineering Degree Programs

Overall, there was considerable consistency across the SMEs in rating the items on the knowledge list. Only 5% of knowledge categories could not be assigned specific educational level ratings due to a high degree of variation in ratings among the SMEs. Thus, it appears there is substantial similarity across engineering schools in the coverage of items on the knowledge list.

The distribution of the educational level ratings for the over 200 knowledge categories on the total knowledge list is shown in Table 1. For example, 9% of the knowledge categories were rated as being covered in high school courses required for entry into college engineering programs.

Table 1. Distribution of Educational Level Ratings for Total Knowledge List

Educational Level		Percentage Distribution
High School		9%
Core Curriculum		17%
Upper Division		47%
Nuclear	(36%)	
Other than Nuclear (Chemical, Electrical, Mechanical)	(11%)	
Not Covered		22%
No Rating[a]		5%

[a] Due to insufficient agreement among SMEs as to whether knowledge category was covered or not covered.

Table 1 indicates *where* the knowledge is taught by specific educational levels and majors. The percentages indicate the percent of knowledge categories covered in *required* courses. It is thus a conservative estimate of coverage of job-related knowledge because elective courses are not included. The percentages do not indicate what an individual student would cover because students major only in one area and take a considerable number of elective courses in addition to requirements. This table shows the extent to which job-related academic knowledge is college-level material.

A major conclusion of Table 1 is that of the academic knowledge required for nuclear power plant operators, about 65% is covered in college engineering required courses. To translate in terms of individual students, it can be said that a student with a bachelor's degree in nuclear engineering would cover, at a minimum, 62% of the academic job-related knowledge (9% in high school prerequisites, 17% in core requirements, and 36% in nuclear engineering upper division requirements).

These findings indicate that much of the academic knowledge needed by nuclear power plant licensed operators is covered in college nuclear engineering curriculum. Thus, it might seem reasonable to consider a college engineering degree as an educational qualification. However, it is also important to consider whether a potential educational qualification may be excessive. In other words, a large proportion of the academic knowledge needed by nuclear power plant licensed operators could be obtained by earning a baccalaureate degree in nuclear engineering, but there may be much more academic content in a nuclear engineering degree program than what is required on the job for a nuclear power plant operator position.

The SMEs estimated the amount the covered job-related academic knowledge represented of the total material covered in the engineering curriculum. There was a great deal of variation among the SMEs in these estimates, indicating both the difficulty of making such a global judgment and variation across individual school curricula. However, the mean ratings indicate that from 60% to 80% of the engineering core curriculum covers material outside that which was specifically identified as job-relevant by the job analysis, and from 40% to 60% of the nuclear engineering upper division curriculum covers material not on the academic knowledge list for reactor operators.

Extent of Job-Relevant Knowledge Covered by Specialized Educational Programs

The sample of eight programs studied cover the spectrum of the types of specialized educational programs being used by the nuclear industry for licensed reactor operators. All of the programs in the sample serve workers at nuclear power plants who are currently licensed or in training for licensing at the RO and/or SRO level(s); two of the programs are directed at Shift Technical Advisors. In addition, some of the programs serve a general student population in preparation for entry into reactor operator positions in the nuclear industry. In most cases, the continuing education section of the educational institution coordinates the development of programs, which generally involves combining courses from engineering or engineering technology departments, science and mathematics departments, and at times junior college courses and plant training courses which have been evaluated for granting of college credits.

The three coursework programs are all associated with degree programs, so that students may apply credits earned toward a degree. Two of the coursework programs serve Shift Technical Advisors as well as Senior Operators. The three associate degree programs are all in nuclear technology, in contrast to the two bachelor degree programs in the sample which are not in nuclear technology nor in nuclear engineering.

The three coursework programs (Schools C-1, C-2, and C-3) are drawn from the wide range of these type of programs. School C-3 encompasses 36 credit hours, compared to 66 hours for School C-1 and 122 hours for School C-2 (converted to quarter credit hours). All of the coursework programs are comprised of a set of required technical courses; they do not have elective or non-technical courses as part of the program.

The A.S. degree programs (Schools AS-1, AS-2, and AS-3) also vary in terms of total credit hours, (from 65 to 120 credit hours). All the A.S. degree programs also require some credits in non-technical areas such as humanities and social sciences.

The B.S. degree programs (Schools BS-1 and BS-2) are the most extensive in terms of total credit hours (203 and 192 hours, respectively). Their number of required technical credits are similar to the more extensive coursework and A.S. degree programs, but they have the greatest non-technical credit requirements. They also include technical electives as part of the program, which generally is not part of the coursework and A.S. degree programs.

The extent of coverage of the complete list of job-related academic knowledge by specialized educational programs was determined by computing the percentage of the over 200 knowledge categories from the academic knowledge list receiving a mean rating of "substantial coverage" (mean score greater than 3.5 on a 5 point rating scale). When at least two of the three raters for an individual program indicated the content of a knowledge category was not directly taught in a school curriculum but would be prerequisite to other content in the curriculum, the category was designated as prerequisite. Where this prerequisite knowledge would be covered was not addressed; presumably it would be covered either in high school level coursework or in plant training courses taken prior to entry into the specialized educational programs.

The results indicate that there is very little knowledge list content that is prerequisite to the content taught in the specialized educational programs. On average, only 4% of the knowledge categories were identified as prerequisites; the individual programs ranged from 2% to 8% of the knowledge list content as prerequisite material.

A review of the overall coverage of identified job-related knowledge by individual programs indicates that the curriculum of School C-2 provides the greatest coverage of the knowledge list content; 63% of all the knowledge categories are taught in this coursework program. School AS-1, School BS-2, and School C-1 all cover approximately half of the total knowledge list content. The remaining programs, Schools AS-2 and AS-3, School BS-1, and School C-3 cover less than one third of the knowledge categories. In five of the eight schools (C-1, C-2, C-3, AS-1, and AS-2) approximately two thirds of the technical coursework covers items from the knowledge list; in the remaining three schools (AS-3, BS-1, BS-2) a little less than half of all the required technical material is devoted to the knowledge list items.

The most striking feature of the school profiles is the variation across the individual programs. The schools differ substantially in the extent of job-related content being taught.

Combining the results of the individual schools by program type indicates no differences among the types of programs in terms of extent of overall coverage. On the average, each type of program covers approximately 35%-40% of the knowledge categories. This is due to the variation across individual programs within each type, described above. Two of the three coursework programs, one of the three A.S. degree programs, and one of the two B.S. degree programs cover half or more of the total knowledge list, while one coursework program, two A.S. degree programs, and one B.S. degree program covers less than a third of the knowledge list content.

These findings demonstrate that there is no particular type of specialized educational program that consistently provides more substantial coverage of the job-related knowledge than other program types.

Comparison of Subject Matter Coverage by Specialized Programs and B.S. Degree in Nuclear Engineering

Mathematics was the only subject area where a considerable portion of the job-relevant knowledge was a prerequisite to the math courses in each program. For most of the programs, between 1/3 and 1/2 of the mathematics knowledge categories were prerequisites to the mathematics taught in a curriculum. Combining prerequisites and direct coverage in the curriculum, Mathematics also was the subject most completely covered across all schools. At completion of the programs, students would have covered at least 2/3 of the Mathematics knowledge on the knowledge list in seven of the eight schools.

Atomic and Nuclear Physics is substantially covered by six of the schools, ranging from almost 60% to over 90% coverage of knowledge categories in that subject area. In addition, five of the schools cover the majority of the knowledge categories in the areas of Reactor Theory and Health Physics.

Reactor Plant Protection is not covered at all by five schools and is taught minimally by two schools (with less than 25% coverage of this area).

Chemistry and Engineering Drawing are the subject areas least covered in the specialized educational programs. Engineering Drawing is not covered by any of the programs. Seven of the eight schools cover little or none of the job-related chemistry identified on the knowledge list. Four teach none; three teach less than 20%. This is likely to be due to the narrow focus of chemistry that is directly relevant to nuclear reactor operators, which is limited primarily to water chemistry. This specialized area of chemistry is only one small area covered in basic college-level chemistry courses.

The individual schools vary with respect to coverage of the remaining subject areas. For example, half of the schools cover most of Heat Transfer (from 66% to 88%), while half cover little or none. The curricula of the individual schools in the areas of Electrical Science, Materials, Classical Physics, and Instrumentation and Control, similarly, are spread across the range from minimal to substantial coverage of the knowledge categories within these subjects.

Turning to the individual programs, School C-2 provides substantial coverage of most of the subject areas with the exception of Chemistry and Engineering Drawing. Schools AS-1, C-1 and BS-2 also cover a broad range of the subject areas. School AS-3 appears to be focused primarily in the areas related to physics, covering some job-related knowledge in Mathematics, Classical Physics, Atomic and Nuclear Physics, Reactor Theory, Health Physics, and Heat Transfer, and not covering knowledge identified in the other subject areas. School C-3 teaches courses primarily in the areas of Materials, Atomic and Nuclear Physics and Health Physics. Schools BS-1 and AS-2 cover some material across a broader range of subject areas, but only two to three of the subject areas show substantial coverage.

The variation across the schools most likely reflects the tailored nature of these specialized educational programs. These A.S. degree, B.S. degree and coursework programs are, for the most part, used to teach specific areas in conjunction with particular plant training programs.

The nuclear engineering B.S. degree programs cover both basic fundamentals (Mathematics, Electrical Science, Materials, Classical Physics, Heat Transfer and Fluid Flow) and nuclear-oriented subjects (Atomic and Nuclear Physics, Reactor Theory, and Health Physics) quite extensively. Coverage of these subject areas (including prerequisites) ranges from 60% (Electrical Science and Heat Transfer) to 100% (Classical Physics and Atomic and Nuclear Physics).

The B.S.N.E. programs are similar to the specialized programs in the very limited coverage of job-related chemistry and engineering drawing. They differ from the specialized programs in their lack of coverage of Instrumentation and Control.

CONCLUSIONS

The major conclusions of the comparative analysis are:

- Approximately 10% of the academic knowledge needed by ROs and SROs is covered in high school courses that are prerequisites for entrance into college engineering degree programs. This knowledge is primarily in the subject area of mathematics.

- A substantial amount (approximately 2/3) of job-related academic knowledge is covered in college engineering courses.

  - Approximately 65% of the academic knowledge identified as necessary for the positions of RO and SRO is taught in college level engineering courses, either in the core curriculum taken in the first two years (17%), in upper division requirements for the nuclear engineering major (36%), or in other upper division majors (11%).

  - Approximately 20% of the academic knowledge needed by ROs and SROs is not covered either in high school or college engineering programs. This material is primarily in the areas of: water chemistry, reactor plant protection, and engineering drawing.

- College engineering curriculum provides considerable material beyond that identified as necessary for licensed operators.

  - Overall, no more than half of the total engineering core curriculum and the total upper division nuclear engineering major overlaps with academic knowledge needed by licensed operators.

- There is a great deal of variation among specialized programs for reactor operators, ranging from coverage of 15% to 65% of job-related academic knowledge. Half of the schools cover at least 50%, and half cover less than 30% of this knowledge content.

- There is no systematic difference in the job-relatedness of the different types of specialized educational programs: A.S. degree, B.S. degree, and coursework.

- Traditional B.S. degree programs in nuclear engineering cover at least as much job-related knowledge as most of the specialized educational programs.

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EXPERIENCES IN SOLVING THE CHALLENGES OF ON-SITE DEGREE PROGRAMS

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The University of Cincinnati (UC) Nuclear Engineering Program Faculty has now had six years of experience in delivering on-site educational programs to nuclear power plant technical personnel. Programs of this type present a variety of challenges to the faculty, the management of the client utility and to the students who become involved in a particular program. This paper describes how each of these groups can identify and successfully solve these challenges. The solutions we describe are drawn from our own experiences which have been described in some detail elsewhere[1-3]. Other solutions to these challenges are certainly possible. We make no claim for the particular ones we offer, beyond the fact that they have worked over a sustained period of time and that results they have produced have left all three parties mutually satisfied.

FACULTY CHALLENGES

The first and foremost challenge to a nuclear engineering faculty is deciding whether on-site education is an activity that it wants to undertake. The U.C. Nuclear Engineering Faculty is relatively small (6 full-time members) and supports a full range of on-campus academic programs at the BS, MS and PhD levels. Faculty members are also involved in funded research and consulting activities. Supporting an on-site (and off-campus) educational program is obviously an additional commitment by the faculty and one that will inevitably subtract from the faculty man-hours available for on-campus activities. Is the extra effort worthwhile? What are the benefits to the Nuclear Engineering Program as a whole and to the faculty members as individuals? Are these benefits worth the effort and risks that such a non-traditional program entails? Obviously the answer by our faculty has been in the affirmative, but in our view it is essential that the faculty seriously consider the pros and cons of becoming involved in an on-site program before it undertakes such a commitment. The outcome of such faculty considerations has two distinct benefits:

1. If the outcome is a decision to proceed with an on-site program, then there is a high probability of widespread faculty consensus and willingness to contribute to the program. Our experience is that a worthwhile on-site program involves so much effort that the existence of the foregoing conditions are essential prerequisites to a successful program.
2. The considerations produce a thought-provoking debate and analysis of the options and trade-offs involved in different types of on-site program. The outcome helps to define the type of program that the facuty regards as being academically appropriate and worthy of their involvement.

At UC we have gone through this process on at least three occasions. Each time the consensus faculty view has been that involvement in an on-site program is sufficiently positive that the effort should be undertaken provided that the program can be properly structured, the faculty effort level can be controlled, appropriately compensated, and planned for in an orderly fashion. Realizing that these features are essential preconditions to faculty support and involvement, we have been able to shape our program proposals so that they have had these characteristics. Having a clearly defined set of necessary conditions for faculty acceptance prior to entering into internal and external negotiating sessions has allowed us to leave such sessions with client and University administration approval of the desired policies. It is unlikely that such an outcome could have been achieved without the prior existence of a consensus faculty viewpoint.

UTILITY MANAGEMENT CHALLENGES

The management of the client utility sponsoring an on-site educational program must answer questions similar to those considered by the faculty. Is such a program worthwhile? Does it produce sufficient benefits to justify the resources it will consume? Again these questions are most appropriately considered prior to making the decision to sponsor the program. In all the programs we have been associated with there is no doubt that the management has seriously debated these questions, although not always on the time scale we suggest.

Generally we have not been participants in the utility management sessions where these questions have been considered. All we can report are the answers the sessions have produced as reflected in the policy positions stated by management representatives. Certainly the primary justification for the utility management of the first U.C. on-site programs was the perceived necessity of responding to the TMI Action Plan Requirements set forth by the NRC in late 1980.[4-5] In that era the simplest answer to the foregoing questions for utility management was "mandated by regulatory requirements". Even at the time, however, some elements in utility management realized that there were other reasons for providing on-site educational programs for their technical personnel, and one of the U.C. programs was requested and sponsored for non-mandated reasons. Currently our perception is that although regulatory mandates still play a role in the utility decision-making process, they are no longer the primary reason for utility sponsorship of our programs.

The primary benefits from the utility management viewpoint appear to us to be the following:

1. Some degree of genuine enhancement in the technical proficiency of on-site engineering personnel.
2. A reasonably objective, external measure of the intellectual ability, professional maturity and depth of professional commitment of a portion of their engineering staff. The usefulness of objective information of this type (even though incomplete and imperfect) can be of significant benefit in making personnel decisions.
3. A safety-valve for the more determined and ambitious on-site professional staff. The rate of turnover among the professional staff is a continual and legitimate concern of the utility management. The perception of staff members that management is providing a way for them to develop and advance their professional skills furnishes some degree of relief from the common daily demands of their job assignments. The significance of this aspect to utility management is enhanced because the individuals who become involved in on-site programs are often exactly the same people who are most important in maintaining the utility's technical proficiency on an independent basis.

4. The availability of an on-site program makes site employment significantly more attractive. This feature can contribute significantly in the recruitment of new employees and in making site assignments more attractive to current employees.

STUDENT CHALLENGES

In our experience the primary challenge facing a student who becomes involved in an on-site program is finding the time to make the extra effort that academic courses require while still carrying out their daily professional responsibilities. Since these responsibilities often seem to require more than 40 hours per week and at least occasional traveling, it is a real challenge for a student to arrange his schedule so that he can simultaneously undertake academic course work. A further challenge is provided by the necessarily "long-haul" aspect of programs that meet all of the operational constraints and still have the desired characteristics: On-site programs (at least for professional engineering personnel who usually have many other essential commitments), are always part-time and often after-hour efforts for the students. With these constraints it is inevitable that a multi-year commitment is required on the part of the student if he is to obtain a degree.

ONE SET OF SOLUTIONS: THE PEP PROGRAM

U.C. with the support of Cleveland Electric Illumniating Company (CEI) has developed an on-site graduate level educational program (PEP) for professional engineers at the Perry site. The program is now in its third year of operation and provides CEI employees with the opportunity to earn a Masters degree in Nuclear Engineering. CEI (and other on-site engineers) can also take selected individual courses for purposes of professional development without pursuing the entire M.S. degree program. A unique feature of the program is the use of the "mixed-mode" format to deliver most of the instruction. The mixed-mode format appears to be the optimum way to deliver a multi-year graduate program to an off-campus site, particularly when all of the instructors involved have a variety of other commitments.

PEP was initiated in the Summer of 1984 after several meetings between CEI management and faculty members of U.C.'s Nuclear Engineering Program. The outcome of these meetings was the decision to proceed with the program and to provide it with the following features:

1. The majority (at least three-quarters) of the instruction to take place at the Perry site.
2. The delivery rate of the course material to be at a rapid enough pace that participants can see they are making real progress towards a graduate degree. One course per calendar quarter was the delivery rate decided upon.
3. The course delivery rate to be compatible with the constraint that the partcipants have 40-hour per week professional obligations while a course is being taught.
4. The course delivery mode to have sufficient flexibility to accomodate the needs of participants who miss an occasional class because of shift work assignments or higher priority professional obligations.
5. An integral part of the program will be a practically oriented thesis or project (probably Perry-specific) carried out by the participants on an individual basis.
6. All program costs incurred by the University of Cincinnati to be met by Cleveland Electric.

Several methods of course delivery were investigated before a mixed-mode delivery format was decided upon. In the mixed-mode delivery format, courses are presented in a combination of in-person lectures and videotape films. Typically, three of the four courses offered each year use the mixed-mode format. The fourth course is delivered in-person by a faculty member who spends one day each week on-site. In either format, the class meets for 2 1/2 hours, one evening per week for a total of 10 weeks. Students also have homework and study assignments which typically require an additional 5-7 hours per week.

In the mixed-mode format, the instructor conducts the first class session in-person which allows him to establish personal contact with the students, distribute books, process registration materials, present the first lecture and explain the course format. The instructor can also use this visit to collect technical information about the Perry Plant that can be used as examples for the course.

The second week typically begins the first of three, 3-week cycles of videotape instruction and in-person lectures. Each cycle commences with two weeks of videotape delivery followed by a third week in which the videotapes are supplemented with an in-person lecture session. The last week of the third cycle culminates in a 1-hour in-person review session followed by a final examination conducted by the instructor. During the videotape delivery mode weeks, the instructor is available at a specified time (telephone office hours) to receive telephone calls from members of the class, either individually initiated, or on a conference call basis.

The selected delivery mode has the advantage of being able to reschedule videotapes for participants who have not been able to be present for the scheduled showing. It also has the advantage that an entire course can be repeated at a later date at a considerably reduced cost. Despite the many demands on their time 45 students have partipated in at least one or more of the first eleven PEP courses. The first M.S. degree graduates of the program are projected for June 1988.

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JMC2

GETTING THE MOST OUT OF TRAINING AND EDUCATION THROUGH PERSONAL AWARENESS

John E. Carroll

It should be a fairly simple premise to say that the sum total of all of the efforts in Education and Training should be a safe, efficient and productive operation. I would narrow the focus even more for the moment, however, to the point of concentration on the Safety aspect. Hans Blix, the Director General of the International Atomic Energy Agency, in his presentation at the INPO CEO Workshop in November 1986 addressed this when he pointed out that, "Safety, whether in aviation, neuclear power or any other industry, is a continuously evolving business." He continued, "The occurrence of two significant neuclear accidents in two leading neuclear states in the course of seven years has raised questions about whether, and to what extent, some basic safety principles might usefully be defined to which all States would more strongly commit themselves."

Now an initial reaction could rightly be that we have always had safety of operation as the foundation of all planning for our Education and Training programs. In addition, our screening and testing of job applicants, the state-of-the-art of training equipment and the automation of various functions and safety equipment have all been calculated to arrive at an absolute minimum of incidents or accidents. With all the attention that has been given in this regard, why then is it a fact that in 1983 and 1984 more than 50% of all Significant Events in the U. S. Neuclear Industry were a result of inadequate Human Performance? Why is the record unchanged today?

In the report on the Chernobyl accident, the International Atomic Energy Agency stated, "Complacency by operators, managers and infrastructure, engendered by many years of successful operation and by the belief that the unexpected cannot happen, appears to have been a root cause of the Chernobyl accident. It was a major contributor to the Three Mile accident, and it is a central issue in the management of neuclear safety at any reactor." Other root causes in this and other Significant Events have been the human interface with hardware, procedures and, to my mind most importantly, other humans.

The traditional approach in Education and Training has been to primarily address the human interface with hardware and procedures and we can take pride in knowing the effort has been successful when we recognize that today the causal factor in the majority of our events is no longer a problem with the hardware or the procedures. Specifically, at Chernobyl, again quoting Hans Blix, "We learned that flagrant disregard by operating personnel of safety rules and procedures during a testing operation placed Chernobyl Unit 4 in an unstable state from which it surged out of control."

Whenever an investigation into one of these incidents or accidents is conducted, the focus seems to be to try to determine what happened. I would suggest we should shift the emphasis more to why it happened. Why should individuals who have been through an intense selection, education and training process perform in less than an optimum manner? Especially when the results could be catastrophic? If the answer can be found, then the approach to formulating Education and Training programs could be refocused to provide more satisfying and safer results. However, rather than looking for the answer to "why" individuals have acted the way they have in these events, our reaction, in most cases, has been to look for ways to design the individual out of the system - to automate more and thereby make the system more inherently safe and forgiving of operator errors. This approach can be carried just so far, though, before we have to deal with the underlying problem of human action and interaction.

There could be the temptation, on the part of some Utilities, to say that since they haven't had any incidents or accidents of this type that it is not their problem. Consider, however, that any event that receives public attention impacts the entire industry and not just the utility involved. In his address, Hans Blix made the point that "INPO neuclear safety programmes were developed after TMI, out of recognition that the collective fortunes of the members depended on the fortune of each individual member and that the credibility of the strongest depends in no small measure on the credibility of the weakest." At the same CEO workshop, Bill Lee, Chairman of the Board of Duke Power Company, followed Hans Blix on the program and put it even more plainly when he said, "Each of you is hostage to the performance of the poorest in this room!"

I know that every utility has addressed the subject of Human Factors and that courses for supervisors and managers have included subjects to enhance their abilities. The programs have covered items such as Leadership, Interpersonal Communication, Command-responsibilities and Limits, Motivation of Personnel, Problem Analysis and Decision Making. In most cases, though, there is no opportunity for the individual to become aware of how their implementation of the knowledge gained in these areas impacts those with whom they interface and therefore, how the overall operation is affected.

Two recent publications, Good Practice TQ 503 and NUREG/CR-4258 have addressed the subject of Team Training. The emphasis in both cases is on individuals gaining the recognition, the personal awareness, of how they operate in concert with others and that synergy can only be achieved through a team effort. It should also be noted that every member of a team needs to be involved in the training and not just the supervisors.

The aviation industry's accident experience closely parallels that of the utility industry and they have embarked upon a program of training their cockpit crews that I think can be considered as easily transferable to the utilities control room personnel and ultimately to the plant positions with whom they closely relate.

There are many versions of Team Training or Resource Management Training, but one of the more thorough and proven programs is one implemented by United Airlines in 1981. The goals of the program were, in part, to establish an atmosphere of openness in the cockpit, to allow each individual to gain an insight into their style of operation, to understand the various command and leadership responsibilities, to understand how external influences can affect the operation and how synergy can be achieved.

To reach these goals, it was agreed that the training had to be given to all crewmembers, that it had to be a participative program, not a passive one and that it had to be made a part of the recurrent training as well.

A precept of any team training should be that it allows for the recognition and subsequent internalization of the need for a behavioral change, if necessary, on the part of the individual. United's course enables this to take place, because the traditional approach of a stand-up form of instruction is not used, but rather the learning takes place primarily in a team environment where one's peers supply the feedback from which the individual benefits.

The first phase is the use of a text to establish the frame of referance to be used. Next, a seminar is scheduled in which the intellectual understanding of team dynamics is applied in a time-constrained atmosphere. Recurrent training is then given each year, this time in the simulator, using scenarios designed to emphasize the need for teamwork. This training is video-taped and selected portions played back in the debriefing period for peer discussion rather than the traditional instructor critique.

In the six years since the training was implemented by United, there have been some very gratifying results. Broad acceptance by the crewmembers is evidenced by the reports written by Instructors and Supervisors. Individual crews have stated how the principles and concepts imparted in the training have enabled them to handle irregular and emergency situations more effectively. Accident investigations have shown how use of the results of the training have minimized the seriousness of a situation. The most important result, however, is the recognition that individuals have gained on how they impact the operation and that what counts is What is right, not Who is right.

Before the inception of the Resource Management training, United's experience in the loss of airplanes was only slightly better than others in the industry, both domestically and worldwide. Today United's record is four times better than the rest of the world. While it may not be the only factor, Resource Management Training, or team training, certainly has had an unquestioned influence.

Anyone embarking on a team training program must know what the objectives are and then answer the following questions:

- What should be the content of the training?
- How should the training be given?
- When should the training be given?
- Who should conduct the training?

If a thorough approach to the planning and implementation of this form of training is taken, the desired results can be achieved. If not, it will be "just another training program", a square filler that wastes time, energy and resources. Worse yet, the Human Performance causal factor will still dominate in our Significant Events.

United has extended the principles of their team training into every facet of their programs for cockpit crewmembers. As a result, it has become apparent that every training experience is more productive than had been true in the past. With this recognition, I feel secure in saying that a heightened personal awareness gained through team training will enable every individual to get the most from their future education and training experiences.

TEAM TRAINING PROCESS
FOR
NUCLEAR POWER PLANT TECHNICIANS

A.C. Macris

INTRODUCTION

The purpose of team training is the cooperative and coordinated actions of individuals to attain a common goal. Such training requires the development of more sophisticated educational techniques than those previously established for training individuals alone. Extensive research has been conducted to devise methods and techniques to bring about effective team training. This paper discusses current team training methods and presents an instructional strategy for the application of effective team training techniques.

CURRENT TEAM TRAINING

Only recently have attempts been made to define training systems that result in proficient teams. The difficulties with present-day team training are categorized and explained in the following sections.

Individual Training in a Group

Current "text training" is primarily individual training in a team context. Instructors administer programs that focus on the application of individual skills. Individual skills and knowledge are necessary prerequisites to team training. Training of individual skills is fairly straightforward, but the techniques used to train "team behaviors" are quite different. Team actions are based on communication and interaction within a structured group of individuals. Team training will not be effective when the individual skills are not on a par with those of other members. A team cannot develop team behaviors when team members are being used to compensate for a lack of any team member's individual proficiency.

V.A.1.2

Training Through Testing Techniques

Current team training typically begins with a short classroom session in which pertinent aspects of the team task are reviewed. This is followed by a series of exercises designed to provide individuals with experience in their respective jobs.

The typical instructor's role is one of recording his observations for a critique of the exercise results. The team is later gathered for discussion of errors. This approach to training stresses the negative aspects of performance while providing little positive feedback for correct and desirable actions. As a result, teams acquire a good deal of practice in a trial-and-error fashion.

The most desirable approach to learning is a combination of correction of errors and reward for proper goal-directed behaviors. This shaping procedure is designed to promote a positive and successful team training environment.

Research has established that correction must be based on feedback that is properly timed and appropriate to the level of the team. Many factors must be considered when providing knowledge of performance to a team:

- The information to be provided.
- When to provide the information.
- The form of the information feedback.
- Who provides the feedback.
- How much information should be provided at each stage of learning.

Research suggests that individuals rely on feedback inherent in the tasks as well as information external to the immediate environment. This makes the source and timing of external feedback critical. Too much knowledge of performance early in training can cause the team to emphasize deficient areas to the exclusion of other important elements of a problem.

Defining Team Behaviors

A variety of definitions exist for team behaviors. These definitions tend to confuse the establishment of standards for effective training. The most familiar team behaviors defined thus far are communications and coordination. Attempts at training these team behaviors have tended to revert back to individual training techniques. More precise definitions of team behaviors as related to training of technicians are provided in this paper which better define the team training needs.

Team Concept

Historically, the structure and function of individuals designated as a team has not been well understood. In addition, there have been inconstancies, in definitions on what constitutes a team. This presents obstacles to the development of effective team training techniques.

In summary, difficulties with team training, such as training individuals in groups, attempting to train through testing, inadequate definition of team behaviors, and an inconsistent concept of team structure, have contributed to the difficulties in applying the team training research in real world situations.

APPROACH TO TEAM TRAINING

Three steps are necessary in developing team training:

- Team definition.
- Identifying desired and appropriate qualities.
- Development of necessary training techniques.

The above represent the logical sequence for any training approach, starting with statements of how is trained and ending with how the training is conducted. The last step in this approach is discussed in the "Instructional Delivery System" discussed later in this paper.

Team Characteristics

Reviews of current team training literature provide diverse definitions of teams. Klaus and Glasser (1968) have determined a list of characteristics that are particularly well suited to operational team definition. These characteristics, with minor modifications, embody the concept of a team as it applies to the nuclear industry.

A team is:

- Relatively rigid in structure, organization and communication.
- Well defined for member assignments so that each member's contribution can be anticipated.
- Dependent on cooperative, coordinated participation of several specialized individuals whose activities contain little overlap and who must perform their tasks to some minimum level of proficiency.
- Often involved with systems or tasks requiring perceptual-motor activities.
- Able to be guided in on-the-job performance based on a task analysis of the team's equipment, goals, or situations.

Definitions of Maintenance Teams

The focus of team definitions has been directed at operational teams. These teams are relatively easy to define based upon the above characteristics and their defined structure. Definitions of maintenance teams is difficult, but can be generalized into three categories; Core, Augmented and Support Discipline Teams. Each team is discussed below. These definitions are linked to the definitions of maintenance baselines discussed later in this paper. The size and composition of maintenance teams may vary depending upon the maintenance discipline and task. As a result, the following presents definitions based upon these unique considerations.

Core Team

The core maintenance team is defined as, the requisite group of technical personnel within a specific maintenance discipline, necessary to perform a specified task. In general, the individual skills and knowledge of the team members is at a nominal level for frequent and routine tasks.

Augmented Team

The augmented maintenance team is defined as the core team with additional members added from the same discipline. These members usually possess a higher degree of skill and/or knowledge necessary to complete a specific task.

Support Discipline Team

A support discipline team may be a core team or an augmented team from another discipline. This team is introduced when task performance requires additional support in an area outside the expertise of the designated core team.

Qualities of a Team

In an applied setting, team behaviors fall into two major categories: interactive and attitudinal. Interactive behaviors deal with how team members relate to one another and how these interactions impact the accomplishment of team goals. Attitudes are reflections of member views of the team as a capable functional unit.

Classical training system development starts with specific behaviors and translates these into skills/knowledge and resultant training objectives. Team training assumes that prerequisite individual skills and knowledge have been attained and focuses on interactive and attitudinal behaviors. Team behaviors are specified in Table 1.

TABLE 1. QUALITIES OF TEAM DEVELOPMENT

	Level I	Level II	Level III
Interactive Behavior:			
° Integration	Uses plant data to develop useful information	Effectively uses most data available	Anticipates data needs and correlates all data available
° Coordination	Agreement on team procedures	Team procedures accomplished smoothly	Shifts to different procedures without disruption as situation changes
° Adaptability	Adapt to most situational requirements	Adapt standards to all situational requirements	Innovative response to emergent requirements
° Awareness	Awareness of team and goals	Awareness of other member's needs and his individual requirements	Mutual support in overload condition
Attitudes:			
° Motivation	Cooperative	Enthusiastic	Aggressive
° Confidence	Produce required results	Ready for new challenges	Meet all situational demands
° Conformance (by individuals)	Willing to supply team needs	Maximize team effort	Aware of team's dependence on him
° Team Identity (Pride)	Understands role in team	Good role understanding and team identity	Exhibits camaraderie

Levels of proficiency for these behaviors have also been defined. (See Table l.) Level I is a formative stage in which individuals are assigned positions and given an initial goal to function as a cohesive unit. The result of this level is a competent functioning unit able to perform routine maintenance tasks. In Level II training, the individuals have as their goal a growth in knowledge and refinement of skills so that upper levels of team qualities may be achieved. Intermediate level goals are projected as a logical midway training point between the extremes of having a complete absence of team behaviors and having an expert team. Level III's goal is to have an expert quality team capable of handling a wide range of emergent situations.

To illustrate this progression in training, consider "awareness". As an interactive behavior, members of Level I must understand that they are part of a team with specific goals. One level further in team development (Level II) would be an awareness of other individual member functions and needs in addition to the awareness of a team situation and goals. An expert team (Level III) consists of members who mutually support one another in overload conditions, which require an understanding based on the first two levels of team awareness.

TECHNIQUES FOR TRAINING

Separation of Learning and Testing

Training sessions must be divided into processes of acquiring knowledge (learning) and testing of that knowledge. The Optimum environment for learning provides a moderate amount of stress to enhance motivation. Constant evaluation through testing inhibits learning and provides a minimum of learnable information to team members. Tests should logically follow the learning and acquisition stage of instruction. The majority of the team training course is designed for instruction. Evaluation is used to verify that the team has, in fact, mastered specific objectives or to demonstrate training system effectiveness. Only after the team has demonstrated a readiness for evaluation should it be tested. Tests should positively reinforce achievement and monitor progress.

Positive Approach to Training

Learning theory and research have well established the need for constant positive feedback along with correction as the optimum learning environment. Positive learning techniques are aimed at preventing mistakes before they occur and thereby minimizing the need for negative feedback. The approach is guided by these points:

- All training is designed to keep the team in control of the problem. Correct performance is rewarded by the instructor during training and afterwards during discussion of the training event.
- Team training assumes that individual skills and knowledges are compatible with the level of instruction. When necessary, refresher training is included as a preteam training condition.
- Learning should occur under non-evaluation conditions. To ensure compliance with these conditions, the instructor gives at least a short introduction to training problems sensitizing the team to important exercise parameters.
- Team performance diagnostics are separate from training sequences.
- The team is given opportunities to demonstrate achievement periodically, usually at the end of a training level sequence. This assessment through demonstration can be a positive means of tracking the team's performance.

- Teams have direct involvement in the overall learning process. Instructors encourage teams to self-evaluate their performance at the completion of an exercise.

Integrated Approach to Training

Implementing the positive approach to training is accomplished by integrating the overall instructional strategy with the design of instructional materials. Desirable team behaviors are developed in two fundamental phases. These phases will be referred to as Prerequisite Behavioral Awareness and Maintenance Baseline Operations. The integrated approach comes about through an instructional delivery system that provides step-by-step instructor guidance. The instructor has leeway in adjusting the rate of progress to the needs of the team, by accelerating fast learners or giving additional training for slower learners.

Prerequisite Behavioral Awareness

This first phase of the integrated approach attempts to ensure that uniform behaviors and attitudes (characteristics of productive teams) shaped and encouraged through group interactions. These interactions are designed to foster cooperation and mutual respect among group/team members. Achieving the characteristics of productive teams entails changing or eliminating behaviors and reinforcing positive behaviors through training. This in turn creates the fundamental prerequisite training which is exercised, expanded and improved in the next phase, Maintenance Baseline Operations.

Maintenance Baseline Operations

Training logically begins at the initial competence level of the team. The word "baseline" means the "beginning at the beginning" concept. A baseline of a maintenance evolution is defined as the simplest form of the evolution representing responses to normally encountered situations within optimum conditions.

Each baseline is a conceptual category of maintenance operations based on established goals. Although listed discreetly, baselines overlap and are expected to frequently co-occur. Coincident baselines are used in complex situations as adaptations to emergent conditions.

The training of a team, therefore, logically begins with the baseline alone. Once the baseline is mastered, complicating factors are introduced as a means of tempering teams to stressful conditions. Emphasis is consistently directed toward maintaining baseline procedures when accommodating to increased situational demands. Complications are designed to be assimilated into baseline workings so that fundamental procedures and team actions remain relatively fixed. Adaptation to emergent conditions does not necessitate completely novel sequences of behavior from a team. Teams are trained so that baseline procedures attain a degree of automaticity, leaving more time and mental energy for addressing the unpredictable.

Training baseline behaviors and variations requires a formally structured training program. Each step is based on a clear objective for progressing the team from baseline performance to the expert level.

Four fundamental maintenance baselines have been defined in figures 4-1 thru 4-4. The specifics of each are dependent upon the evolution and maintenance discipline.

TRAINING LEVELS

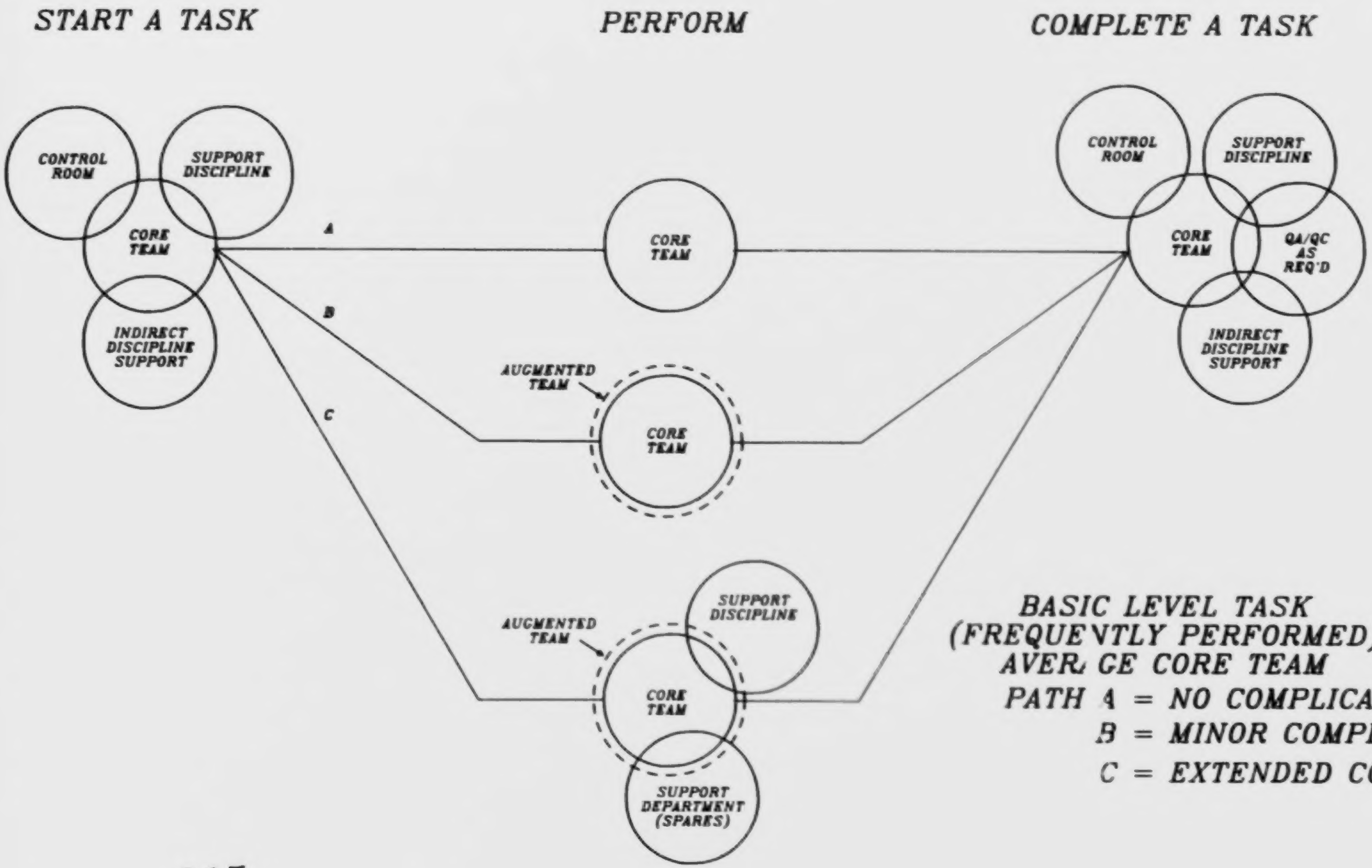
Need for Levels of Training

Teams must start training at levels appropriate to their capabilities and progress as far as possible during the designated training time period. Improvement with training, depends on the particular characteristics of each unit (team).

Teams should not be administered training beyond their skills and abilities. This can be demoralizing and confusing.

NORMAL MAINTENANCE BASELINE

TDPCT1

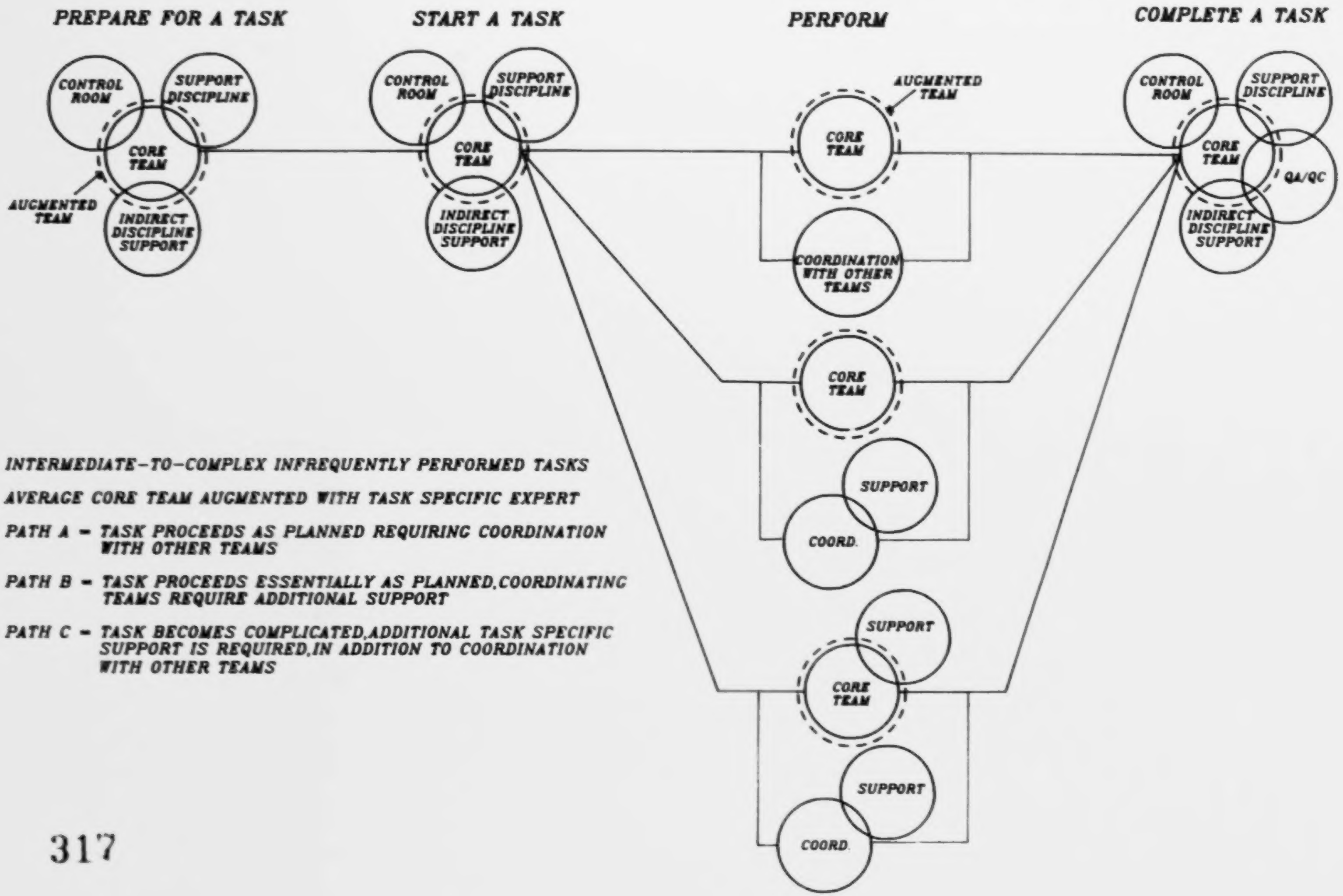

START A TASK
PERFORM
COMPLETE A TASK
CONTROL ROOM
SUPPORT DISCIPLINE
CORE TEAM
INDIRECT DISCIPLINE SUPPORT
A
B
C
CORE TEAM
AUGMENTED TEAM
CORE TEAM
AUGMENTED TEAM
SUPPORT DISCIPLINE
CORE TEAM
SUPPORT DEPARTMENT (SPARES)
CONTROL ROOM
SUPPORT DISCIPLINE
CORE TEAM
QA/QC AS REQ'D
INDIRECT DISCIPLINE SUPPORT

V.A.1.11

BASIC LEVEL TASK
(FREQUENTLY PERFORMED)
AVERAGE CORE TEAM
PATH A = NO COMPLICATIONS
B = MINOR COMPLICATIONS
C = EXTENDED COMPLICATIONS

ABNORMAL MAINTENANCE BASELINE

TDPCT2


PREPARE FOR A TASK
START A TASK
PERFORM
COMPLETE A TASK
CONTROL ROOM
SUPPORT DISCIPLINE
CORE TEAM
AUGMENTED TEAM
INDIRECT DISCIPLINE SUPPORT
CONTROL ROOM
SUPPORT DISCIPLINE
CORE TEAM
INDIRECT DISCIPLINE SUPPORT
AUGMENTED TEAM
CORE TEAM
COORDINATION WITH OTHER TEAMS
CORE TEAM
SUPPORT
COORD.
SUPPORT
CORE TEAM
SUPPORT
COORD.
CONTROL ROOM
SUPPORT DISCIPLINE
CORE TEAM
QA/QC
INDIRECT DISCIPLINE SUPPORT

INTERMEDIATE-TO-COMPLEX INFREQUENTLY PERFORMED TASKS

AVERAGE CORE TEAM AUGMENTED WITH TASK SPECIFIC EXPERT

PATH A - TASK PROCEEDS AS PLANNED REQUIRING COORDINATION WITH OTHER TEAMS

PATH B - TASK PROCEEDS ESSENTIALLY AS PLANNED, COORDINATING TEAMS REQUIRE ADDITIONAL SUPPORT

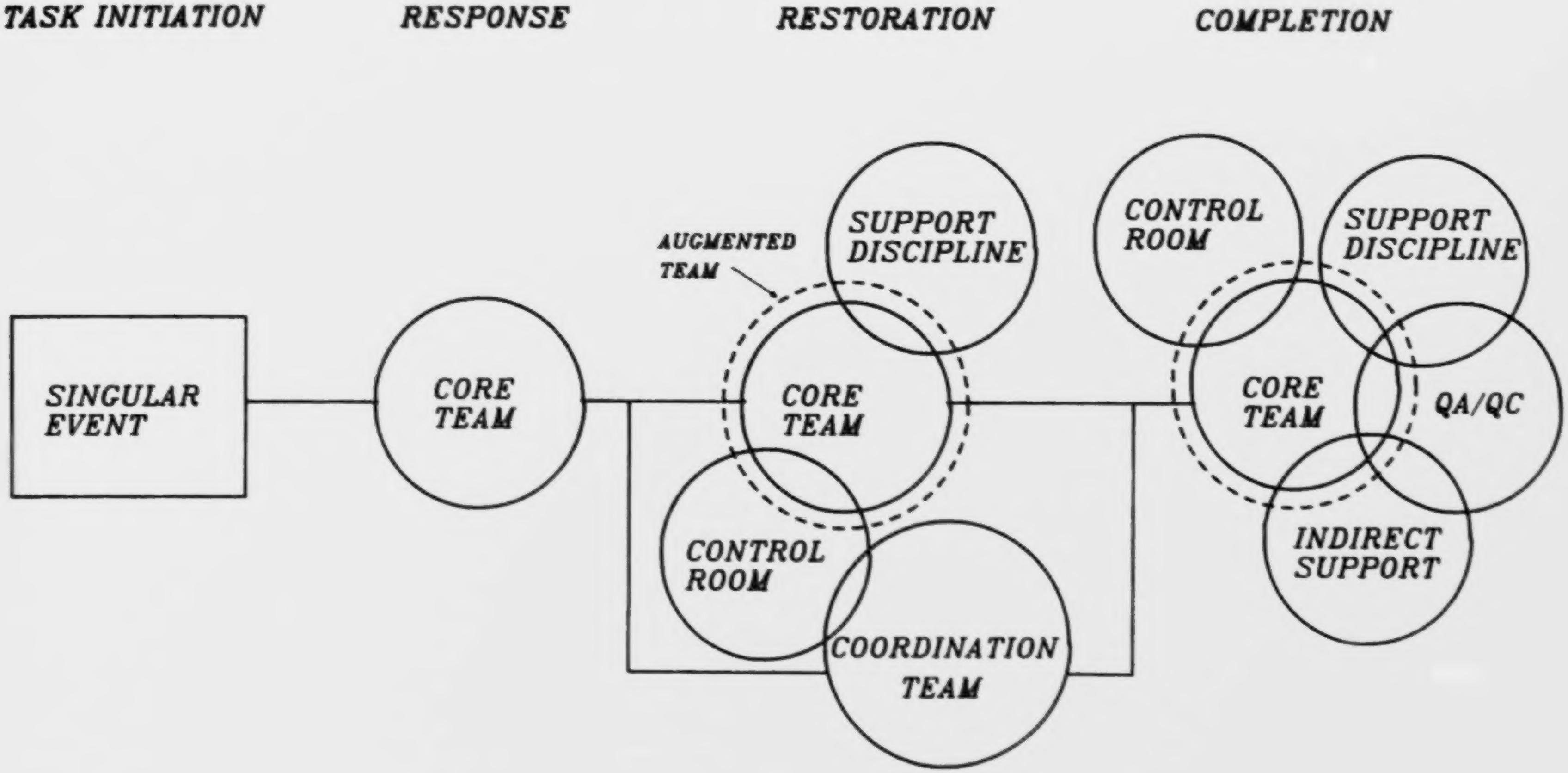
PATH C - TASK BECOMES COMPLICATED, ADDITIONAL TASK SPECIFIC SUPPORT IS REQUIRED, IN ADDITION TO COORDINATION WITH OTHER TEAMS

V.A.1.12

EMERGENCY RESPONSE BASELINE

TDPCT3

LEVEL I



TASK INITIATION

RESPONSE

RESTORATION

COMPLETION

SINGULAR EVENT

CORE TEAM

AUGMENTED TEAM

SUPPORT DISCIPLINE

CORE TEAM

CONTROL ROOM

COORDINATION TEAM

CONTROL ROOM

SUPPORT DISCIPLINE

CORE TEAM

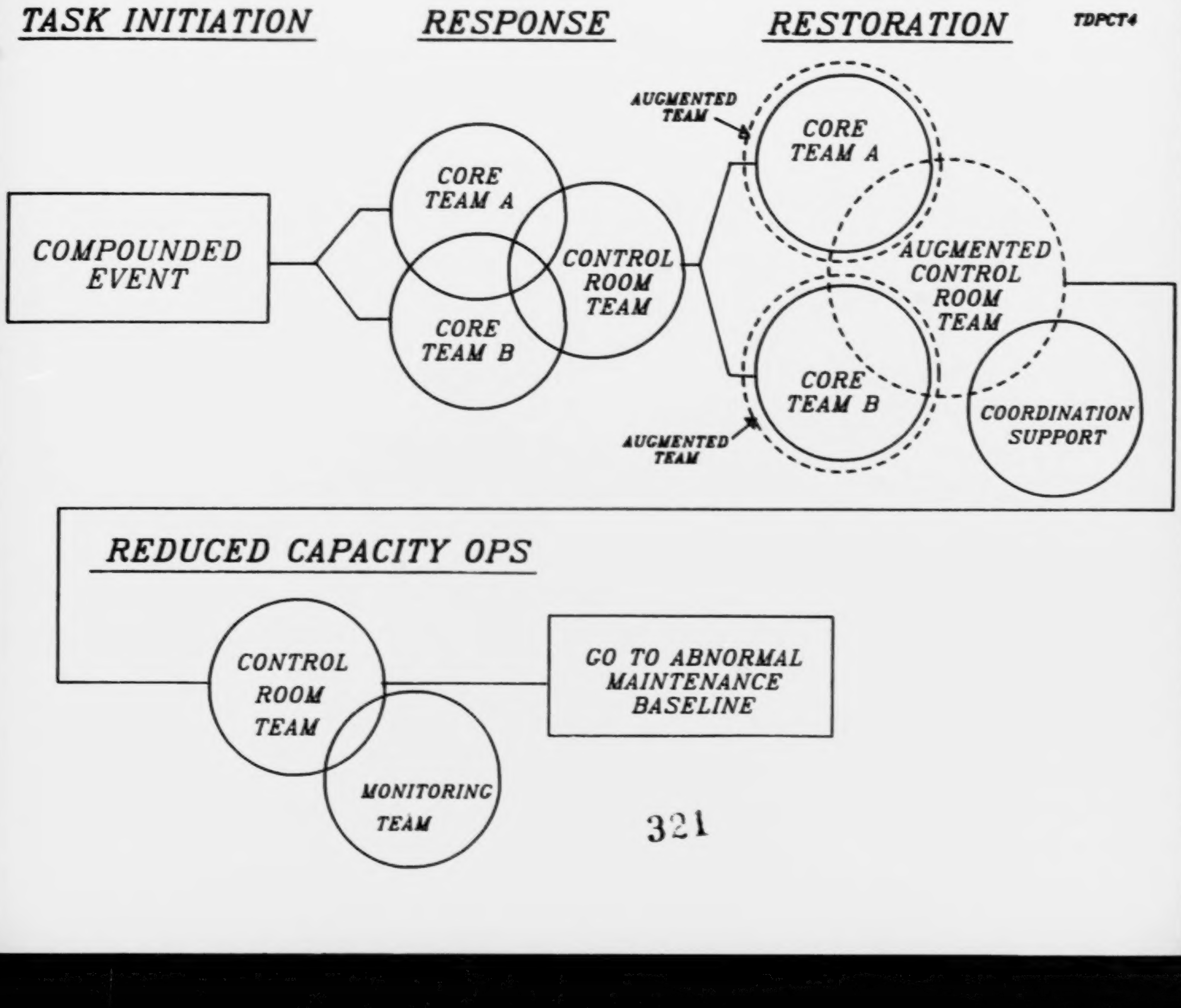
QA/QC

INDIRECT SUPPORT

EMERGENCY RESPONSE BASELINE

LEVEL II

TDPCT4



TASK INITIATION

COMPOUNDED EVENT

RESPONSE

CORE TEAM A

CORE TEAM B

CONTROL ROOM TEAM

RESTORATION

AUGMENTED TEAM

CORE TEAM A

AUGMENTED CONTROL ROOM TEAM

CORE TEAM B

AUGMENTED TEAM

COORDINATION SUPPORT

REDUCED CAPACITY OPS

CONTROL ROOM TEAM

MONITORING TEAM

GO TO ABNORMAL MAINTENANCE BASELINE

Capabilities of teams vary according to combined past individual training, experience, and time spent together as a unit. The training level concept is a recognition of team differences in proficiency and an attempt to tailor the training system to each team's needs. Graduated difficulty of training sessions allows definite starting points tailored to a team's abilities and serves to identify training gains within and between levels.

Three Training Levels

Levels of team proficiency are difficult to establish absolutely and must be somewhat flexible. Proficiency of a team can be expected to vary somewhat from one task to another. Team capabilities are, however, expected to transfer across specific operations, allowing general agreement about broad categories (levels) of ability.

The first step in operationally defining categories of team abilities was the specification of team qualities (Table 1). The next step is the definition, in appropriate terms, of what is expected from the team at each training level. The three training levels are defined as follows:

Level I represents the minimum level of performance required of a core team and/or augmented core team, such that the team can successfully perform the normal maintenance baselines. The goal of training in Level I is to have the the individual members of the team function as a unit. The team must meet the minimum requirements for accomplishing all normal baselines with sufficient team behaviors and proficiency.

Level II. A Level II team should function as a unit with increased proficiency, capable of completing normal and abnormal baselines and variations. Completion of Level II training is designed to be the norm. Initially, the norm will be arbitrarily set at a level based on Level II training objectives and subjective capability definitions. After training is in place, data collection over many team training periods will be used to identify specific performance standards that can be normalized to the average.

Level III represents advanced team achievement. This level represents complex interactions of baselines and variations where the team must exercise the most sophisticated of emergent qualities. Where Level III training is administered, it actually enhances the team's experience levels to an "expert" team.

INSTRUCTIONAL DELIVERY SYSTEM

Instructional delivery includes the training process, training techniques, and the development of curriculum materials. Incorporated within these elements are the approaches to team training previously discussed. Team training consists of behavioral awareness, refresher of behavioral aspects, theory/systems refresher, operational refresher (as necessary), and team training. Theory and operator refresher training should be limited to those areas that if not refreshed could degrade team learning. The need for behavioral or, individual technician refresher training can be determined by instructors. Each team member has to be capable at a level compatible with Level I demands to effectively interact as a team member.

Individual capabilities are expected to progress as the team progresses with experience and knowledge gained from time spent in the training environment. Through corrective feedback from instructors and other team members, individuals become better technicians and better team members.

The proposed training techniques have been designed to positively reinforce desirable correct behaviors within teams. The curriculum structure ensures that the team is challenged and interested but not overwhelmed.

Team attitudes, a critical component of team motivation, are enhanced in this manner, resulting in positive feelings about individual and team abilities. Along with implementing this proposed training strategy, some form of instructor orientation to the program is necessary. It is difficult for instructors trained in traditional techniques to quickly assimilate "new and improved" programs. Skepticism and trepidation about a new program can be alleviated by pilot familiarization programs. A pilot program would yield information on the success and feasibility of the new training technique.

The Training Process

Team training is divided into sections, each covering a major area of performance. Each section consists of topics related to training that address areas of performance. A demonstration exercise is used only after a team has mastered the content of each section. Demonstration affords the team an opportunity to show its expertise for a type of task before proceeding to the next topic or section.

Team Training Exercises

Four distinct components comprise each exercise: (1) preexercise discussion, (2) preexercise briefing, (3) administration of the exercise, and (4) postexercise discussion. These are essential for each training exercise to foster positive attitudes toward learning and to reduce the probability of errors during exercises.

- Preexercise discussions - clarify the objectives, intent, and major elements of an exercise.
- Preexercise briefings - outline initial conditions of the ensuing exercise for the team.
- Administration of exercise - the instructors note team and individual compliance with discussed goals.
- Postexercise discussion - instructor leads the team in a discussion of the good and bad aspects of its performance. The instructor's attitude is crucial

at this point since his comments can color what the team thinks of its performance. Instructors can ask leading questions, offer suggestions about alternative actions, and point out deficiencies or mistakes in a manner that constructively examines exercise results.

Instructors are the pivotal factor upon which program success depends. The best training program design is useless unless implemented in the manner for which it was intended.

Assessment Exercises

Opportunities for teams to convince themselves of their abilities is important. An option for the instructor involves the use of assessment exercised. These exercises must, however, cover only those elements previously trained, therefore, well within the team's ability. Upon completion of the assessment exercise, instructors can positively reinforce the desired team behaviors while making an assessment of performance. The aim of assessment is to show positive progress with a fair examination.

Use of the Training Process

The proposed training effort takes more instructional effort than traditional trial-and-error training, but also results in more efficient training. Increased efficiency saves training time since fewer exercises are necessary in this structured program. Using the baseline/variation-to-baseline structure, teams can develop the capacity to handle emergent situations with flexibility. An optimum predetermined learning sequence is followed to develop those team qualities shown in Table 1. Periodic assessment ensures progress and provides guidance to the instructor.

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Fig. 4-1 Normal Maintenance Baseline

Fig. 4-2 Abnormal Maintenance Baseline

Fig. 4-3 Emergency Response Baseline - Level I

Fig. 4-4 Emergency Response Baseline - Level II

EVALUATION OF TEAM SKILLS
FOR CONTROL ROOM CREWS

C. D. Gaddy
J. L. Koontz

ABSTRACT

Although team training has received considerable attention throughout industry, a systematic approach to team skills training has only recently been proposed for control room crews. One important step of the approach to team skills training is evaluation of team skills. This paper describes methods and resources, and program considerations in team skills evaluation. The three areas pertaining to methods and resources are: development of evaluation criteria, preparation of event scenarios, and instructor training and additional resources. The program considerations include sequencing and coordination of team skills evaluation in the context of an overall operator training program.

Team training has received considerable attention from practitioners and researchers. However, much less attention has been paid to developing, practicing, and evaluating team skills. Rather, teams are trained as a unit with the focus on technical skills but without explicit consideration of nontechnical skills such as communications and effective influence.

An approach to team skills training for control room crews has been proposed based on an extensive literature review and a workshop attended by team training experts.[1,2] The five phases of the proposed approach are shown in Figure 1. The focus of this paper is on the fourth phase of the approach, Team Skills Evaluation. Since diagnosis is a team skill that has received considerable attention in the industry, diagnostic activities are also considered in this paper.

EVALUATION METHODS AND RESOURCES

The evaluation of knowledge regarding team skills can be assessed effectively using paper-and-pencil tests following classroom presentations. Examples are provided in Figure 2. The evaluation of team skills is a somewhat more challenging undertaking. An evaluation of team skills will likely take place in a simulator or other simulation such as a control room mockup. The evaluation of team skills in the dynamic context of a simulator requires development of criteria, preparation of scenarios, and instructor training and resources. These three considerations are discussed further in sections that follow.

Development of Evaluation Criteria

Evaluation criteria must be developed based on the learning objectives for the simulator training program. Objectives and criteria can be specified at two levels - generic and operational team skills. Generic team skills are the skills that apply to team performance regardless of the industrial setting. Generic team skills include communications, feedback, effective influence, conflict resolution, and leadership. To assist in the evaluation of generic team skills in the simulator, operational team skills can be used as examples. Operational team skills are situation-specific interaction requirements. A sample section of a checklist for crew evaluation is provided in Figure 3. Sources of information for developing operational team skill examples include job analysis data, and positive and negative critical incidents from past plant operation.

The generic team skills and accompanying operational team skill examples can be prepared in a checklist form for simulator instructors to use during observation and debriefing. Identification of specific points in time during a scenario at which specific team skills can be observed is difficult because of the dynamic nature of crew activities. However, a review of the scenario by the instructors, before the exercise, can identify critical or complex points during the exercise at which effective team skills are most important. Cues or flags for the instructor can then be inserted at these points in the technical portion of the simulator lesson plan.

Preparation of Event Scenarios

Simulator scenarios for use in team skills practice and evaluation can be developed to target critical, complex, or frequent crew interactions in which team skills are particularly important for crew performance.

Ideas for scenarios that can be developed are listed in Figure 4. These types of events often involve requirements for crew interactions that are complex, critical, and frequent. Thus, scenarios that have the characteristics listed in Figure 4 usually provide good opportunities for observation of team skills.

Instructor Training and Additional Resources

Simulator instructor skills of observation and debriefing are particularly critical for team skills evaluation since many of the examples of operational team skills must be inferred from observable crew performance, and checked for accuracy during debriefing. Simulator instructors must observe both the technical and nontechnical skills of the crew.

During the observation, one important consideration is maintaining realism so that crew interactions are performed as they would be during actual plant operation. If, for example, communications within, or to points outside, the control room are not simulated realistically, the crew and the instructors will not have the opportunity to observe this team skill.

Instructor intervention during a simulator exercise is appropriate in certain situations. However, the instructor may want to avoid interjecting comments for the crew, or to avoid freezing an exercise before completion of a task, so that the instructor can observe realistic crew interactions.

During the debriefing, a nondirective approach has been recommended.[1,2] The nondirective approach involves the instructor asking an open-ended question to begin the debriefing, and posing additional questions as needed for a comprehensive debrief. However, most of the debrief can be conducted by the crew members themselves. The crew should be given the opportunity to describe their performance and explain their perceptions of what occurred. Crew members should be encouraged to use good feedback skills among themselves and reinforce good performance. If the crew experienced difficulties, they should be encouraged to generate strategies for overcoming the problem in future identical or similar operational sequences. The advantages of the nondirective approach are numerous: crew members are usually self-critical and often provide insights and criticisms that the simulator instructor might not have been able to observe or interpret, crew members will often accept the peer critique and self critique with less defensiveness than if the suggestions come from an "outsider," and crew members may be more likely to accept strategies for overcoming problems in an exercise if they generate the strategies. Thus, the instructor's role is one of facilitator. The instructor may find the use of videotapes of selected portions of the exercise helpful in stimulating crew discussions of the scenario. Simulator computer printouts from the exercise can also be useful as a reference aid to the crew during debriefing.

PROGRAM CONSIDERATIONS

Program considerations in team skills training include sequencing and coordination of team skills evaluation with other training. Team skills training and evaluation may be most effective if individual crew members are proficient in the technical skills and knowledge required for their jobs. Team skills can then be practiced and evaluated to improve coordination among the individual crew members.

After an initial introduction to team skills for requalification crews during a retraining session, subsequent requalification sessions may include a review of team skills and practice targeted to plant-specific problems encountered in using team skills on shift.

Team skills evaluation can be coordinated with related non-technical training evaluation in areas such as supervisory skills, communication skills, and diagnostic skills, to avoid unnecessary overlap or potentially confusing differences in jargon among similar courses. Team skills evaluation can also be coordinated with relevant technical skills training evaluation such as emergency operating procedures training or mitigation of core damage training.

SUMMARY AND CONCLUSIONS

A systematic approach to team skills training for control room crews has been proposed recently.[1,2] One phase in the approach is team skills evaluation. This paper has discussed considerations in the simulator evaluation of control room crew team skills. The development of evaluation criteria, preparation of scenarios, and instructor training and additional resources have been discussed. The program issues of sequencing and coordination of team skills evaluation in the context of an overall operator training program were also described.

The team skills training area is a relatively new focus for control room crew training. Ongoing research and development efforts in the industry will contribute to improved team skills training in the future. As examples, the Electric Power Research Institute is sponsoring research on a simulator instructor training module and on operator reliability models, the Institute of Nuclear Power Operations is continuing work in the area of developing teamwork and diagnostic skills, and the U.S. Nuclear Regulatory Commission is sponsoring research on operator cognitive modeling. These efforts will provide a greater knowledge base of control room crew performance and training from which to refine team skills training and evaluation.

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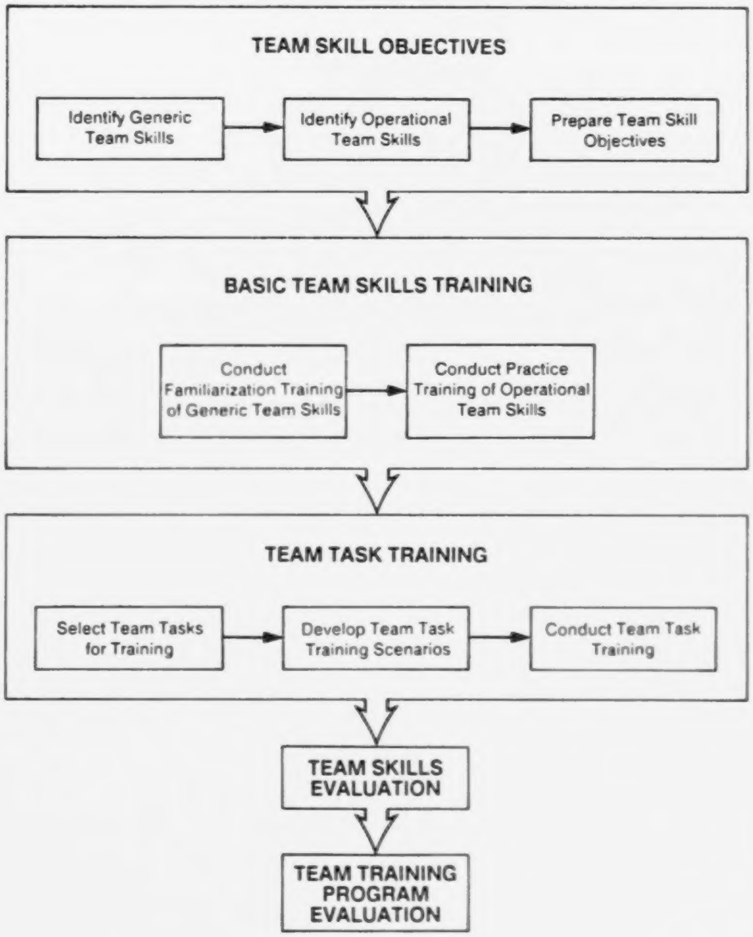
TEAM SKILL OBJECTIVES
Identify Generic Team Skills
Identify Operational Team Skills
Prepare Team Skill Objectives
BASIC TEAM SKILLS TRAINING
Conduct Familiarization Training of Generic Team Skills
Conduct Practice Training of Operational Team Skills
TEAM TASK TRAINING
Select Team Tasks for Training
Develop Team Task Training Scenarios
Conduct Team Task Training
TEAM SKILLS EVALUATION
TEAM TRAINING PROGRAM EVALUATION

Fig. 1. Approach to Team Skills Training

Generic Skill	Examples of Knowledge Required to Meet Classroom Objectives	Examples of Operational Skills Required to Meet Simulator Objectives
Team		
Communication and feedback	Communication model Communication barriers	Exchange information Provide performance feedback
Effective influence	Inquiry Advocacy	Ask question for resolution Assert position
Conflict management	Approach and avoidance Negotiation	Address problems Achieve solutions
Leadership	Roles of leader Leadership styles	Delegate tasks Develop strategies
Diagnostic		
Situation appraisal	Problem recognition Assessment of priority	Collect information Evaluate information
Problem diagnosis	Identification potential causes Tactics to assist problem diagnosis	Monitor critical safety functions Consider wide range possibilities
Planning action	Identification of action alternatives Evaluation of action alternatives	Identify procedure path Compare options
Action and followup	Analysis of effectiveness Recovery from misdiagnosis	Take appropriate action Consider contingency plan
Evaluation Criteria:	Test item for each objective	Checklist item with observable behaviors for each objective

Fig. 2. Overview of Evaluation Approach for Team and Diagnostic Skills

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	YES	NO	N/A
2. Feedback Team members received feedback from other team members which helped them to determine the appropriateness and effectiveness of their actions.	___	___	___

Examples:

a. Accuracy of information was evaluated by asking questions, interpreting the information, and verifying the information with other team members.

b. Performance feedback was given that enabled team members to maintain appropriate actions or to correct deficient performance.

c. Both positive and negative feedback were used.

d. Feedback was given as soon after the behavior as possible.

Comments: ______________________________

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____

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Fig. 3. Sample Portion of Team Skills Evaluation Checklist
Page 1 of 2

YES NO N/A

3. Effective Influence

Team members successfully got their views across and persuaded others that certain action should be taken. ___ ___ ___

Examples:

a. Team members designated other team members to perform specific tasks.

b. Team members asked questions to get information required to establish a position or resolve a question.

c. Team members assertively stated and defended their positions.

d. When involved in group problem solving and decision making, team members asked questions, obtained additional information, and stated their opinions.

Comments: ______________________________

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Fig. 3. Sample Portion of Team Skills Evaluation Checklist
Page 2 of 2

- Single Possible Cause
  - One Non-Obvious Action
  - Multiple Obvious Actions
  - Multiple Non-Obvious Actions
- Multiple Possible Causes
  - One Non-Obvious Action
  - Multiple Obvious Actions
  - Multiple Non-Obvious Actions
- Symptoms of Event Closely Resemble Those of a Different Event
- Low Probability Event with Serious Consequences
- Time-Critical Events
- Necessity for Consideration of Plant Historical Data (Past Few Hours of Operation)
- Instrumentation Failure
- Confederate on Crew
  - Operator Withholds Information
  - Sabotage

Fig. 4. Types of Operating Event Scenarios for Team Skills Training and Evaluation

DEVELOPMENT OF BWR AND PWR EVENT DESCRIPTIONS FOR NUCLEAR FACILITY SIMULATOR TRAINING *

R. J. Carter
C. R. Bovell

ABSTRACT

A number of tools that can aid nuclear facility training developers in designing realistic simulator scenarios have been developed. This paper describes each of the tools, i.e., event lists, events-by-competencies matrices, and event descriptions, and illustrates how the tools can be used to construct scenarios.

INTRODUCTION

Background

The U.S. Nuclear Regulatory Commission (NRC) is responsible for: prescribing uniform conditions for licensing individuals as operators of nuclear production and utilization facilities; determining the qualifications of these individuals; and issuing licenses to such individuals (Ref. 1). This operator licensing system is comprised of both a written and an operating examination. The operating exam is further divided into two parts, oral and simulator. These three examinations are oriented towards determining whether the applicant for an operator's license has learned to operate a facility competently and safely, and additionally, in the case of a senior reactor operator (SRO), whether the applicant has learned to direct the activities of licensed operators competently and safely.

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Guidance to the facility licensee in regards to the simulator exam is detailed in paragraph 23 of part 55 to title 10 of the Code of Federal Regulations (Ref. 2). It states that the simulator examinations for reactor operator (RO) and SRO applicants are generally similar in scope and require each applicant to demonstrate an understanding of and the ability to perform the actions necessary to accomplish a list of 13 items. Paragraph 23 also says that the content is identified, in part, from information in the final safety analysis report, operating manuals, facility license and license amendments, licensee event reports, and learning objectives derived from a systematic training analysis performed by each facility licensee.

NUREG-1021 (Ref. 3) provides the policy and guidance to NRC operator licensing examiners and establishes the procedures and practices for the examination and licensing of applicants for NRC operator licenses. It is intended to assist NRC examiners and facility licensees to understand the exam process better and to provide equitable and consistent administration of examinations to all candidates for either RO or SRO licenses by NRC examiners. Guidance and policy on the administration, scope, and objectives of the operating and simulator exams are detailed in examiner standards (ES) 301 - 305 and 501 - 502, respectively.

Overview

In 1982, the Office of Nuclear Reactor Regulation at the NRC started a program which is oriented towards improving the validity of the operator licensing examination and the reliability of the exam process. Spilberg described the project and the issues and problems which are being addressed at a previous Training of Nuclear Facility Personnel symposium (Ref. 4). Oak Ridge National Laboratory has recently completed a research project which was peformed in support of this NRC program. The purpose of the effort was to develop a set of tools for examiners to use during the construction of scenarios for boiling-water reactor (BWR) and pressurized-water reactor (BWR) simulator exams. The focus of the project was on the generation of

BWR and PWR event lists, a mapping of the competencies which are scored on the simulator examination to the events, and the design of off-normal, i.e., abnormal and emergency, event descriptions. While these tools were created for use by the NRC in operator licensing, they seem to be applicable to the nuclear power industry as a whole and can be used by a facility's training department in its design of scenarios for simulator training.

SCENARIO PREPARATION TOOLS

Event Lists

Four event lists consisting of 87 events were constructed. The breakdown of these events in terms of reactor type and severity of event are as follows:

a. BWR-abnormal - 26
b. BWR-emergency - 22
c. PWR-abnormal - 26
d. PWR-emergency - 13

The events were selected based on the following criteria:

a. The event should be a significant casualty or abnormality.
b. The event should be able to be replicated on the majority of plant-referenced simulators in use today.
c. The event should be able to be effectively administered and evaluated within the time limits of a typical simulator exam.
d. The event should provide a useful base upon which to evaluate candidate eligibility for licensure.

The source data for the generation of the event lists consisted of the Institute for Nuclear Power Operations (INPO) job-task analysis, American National Standard 3.5 (Ref. 5), an event list derived during an NRC examiners workshop**, emergency procedure guidelines (EPG), and other related references. Tables 1 - 4 present the four event lists.

Events-By-Competencies Matrices

The eight competencies, as described in revision 2 to ES-302 in NUREG-1021, were mapped to the BWR and PWR events. Each event was

Table 1. Boiling-Water Reactor Abnormal Events

Master Feedwater Controller Failure
Nuclear Instrument Channel Failure
Rod Position Indicating System Failure
One Reactor Recirculation Pump Trip
Trip of Both Recirculation Pumps
Recirculation Pump Seal Failure
Scoop Tube Lock
Increasing Suppression Pool Temperature
Drywell Cooler Failure
Stuck Control Rod
Uncoupled Control Rod
Control Rod Drift
Control Rod Drive Hydraulic Pump Trip
Loss of All CRD Hydraulic Pumps
CRD Flow Control Valve Failure
Condensate or Condensate Booster Pump Trip
Reactor Feedwater Pump Trip
Loss of Feedwater Heater Extraction Steam
Stator Cooling Water Pump Trip
Steam Jet Air Ejector Malfunction
Loss of One Reactor Protection System Bus
Area Radiation Monitoring System Alarm
High Main Steam Line Radiation
High Ventilation Exhaust Radiation
Inadvertant HPCI or RCIC Initiation
Loss of One RBCCW Pump

Table 2. Boiling-Water Reactor Abnormal Events

Reactor Scram With MSIVs Open
Reactor Scram With MSIVs Closed
Loss of Shutdown Cooling
Gross Fuel Failure
Excessive Reactor Cooldown Rate
Anticipated Transient Without Scram
Stuck Open Main Steam Safety/Relief Valve
Small Break Loss of Coolant Accident
Reactor Coolant Leakage Outside Primary Containment
Jet Pump Failure
High Suppression Pool Water Temperature
Main Turbine or Generator Trip
Main Turbine or Generator Trip Without Bypass Valves
Loss of Condenser Circulating Water
Loss of Feedwater System
Loss of All High Pressure Feedwater
Loss of Plant Control/Instrument Air
EHC Pressure Regulator Failure (All Valves Open)
Loss of Nuclear Service Water
Loss of Reactor Building Closed Cooling Water System
Loss of Off-Site Power
Loss of All AC Power (Station Blackout)

Table 3. Pressurized-Water Reactor Abnormal Events

Loss of RCS Makeup
Loss of Automatic Pressurizer Pressure Control
Failure of Pressurizer Spray Valve
Loss of Automatic Pressurizer Level Control
Progressive Failure of No. 1 Seal in RCP
Failure of Steam Dump to Open
Steam Generator Safety Valve Fails Open and Fails to Reseat
Steam Generator Level Control Failure High/Low
Dropped Control Rod
Inoperable or Stuck Control Rod
Inadvertant Boration at Power
Inadvertant Dilution at Power
Failure of N-44 High
Loss of Instrument Air
Failure of Turbine to Runback Automatically and Manually
Failure of Impulse Pressure Transmitter (Low)
Steam Generator Tube Leak Within Capacity of Charging Pump
Loss of Condenser Circulating Pump
Criticality Outside Expected Band
Failure of Loop Temperature Instrumentation High/Low
Loss of One Main Feedwater Pump at High Power
Spontaneous Opening of the Main Generator Output Breakers
Loss of RCP Without Reactor Trip
Main Steam Leak Inside Containment
Rupture in Letdown Nonregenerative Heatexchanger to CCW
Failure of Pressurizer Control Bank Heaters

Table 4. Pressurized-Water Reactor Emergency Events

Reactor Trip
Large Break LOCA - Reactor Trip With Safety Injection
PZR/PORV Failure to Open
Steam Generator Tube Rupture
Failure of Main Turbine to Trip
Small Break Loss of Coolant Accident
Anticipated Transient Without Scram
Loss of Auxiliary Feedwater - Inadequate Core Cooling
Loss of Off-Site Power
Station Blackout - Loss of All AC Power
Control Room Fire Requiring Evacuation
Main Steam Break Inside Containment
RHR LOCA - Complete Loss of RHR

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analyzed in an iterative fashion by job position, i.e., RO, SRO, and balance-of-plant operator (BOP). The purpose of this analysis was to determine whether the event provided enough opportunity for the examiner to observe each of the competencies. Four events-by-competencies matrices were arranged based upon the results of the analyses. In each matrix the events are the rows and the competencies are the columns; an "X" appears in a cell of the matrix if it was determined that a competency is exercised by a specific operator during an event. These matrices aid in the selection of a sufficient number of events and ensure that each candidate demonstrates each of the applicable competencies over the course of the simulator examination. A page from one of the competency matrices is shown in Table 5.

Event Descriptions

An event description of about 2-4 pages was prepared for each of the events. Each was written to be as generic, i.e., apply to many plants, as possible. The descriptions for the abnormal events were designed using available event-based plant procedures. The emergency event descriptions were developed using symptom-based EPGs from various owners groups (Refs. 6-9). Each event description is organized into two major parts: a cover sheet and a progression of operator actions. An example event description is exhibited as Table 6.

Cover Sheet

The cover sheet presents the following general information:

1. Operating Sequence--The title of the event.
2. Nuclear Steam Supply System Vendor/Reactor Type--The nuclear steam supply system vendor(s), i.e., General Electric, Westinghouse, Combustion Engineering, and/or Babcock & Wilcox, and the type of reactor.

** The examiners workshop was held at the NRC headquarters in Bethesda, Maryland on August 8, 1985.

Table 5. A Page from a Competency Matrix

PWR ABNORMAL EVENTS COMPETENCY MATRIX

COMPETENCIES

EVENTS	S = SRO R = RO B = BOP	UNDERSTANDING/ INTERPRETATION OF ANNUNCIATOR/ ALARM SIGNALS	DIAGNOSIS OF EVENTS/ CONDITIONS BASED ON SIGNALS/READINGS	UNDERSTANDING OF INSTRUMENT/SYSTEM RESPONSE	COMPLIANCE/USE OF TECHNICAL SPECIFICATIONS	COMPLIANCE/USE OF PROCEDURES	CONTROL BOARD OPERATIONS (RO AND INSTANT SRO)	SUPERVISORY ABILITY (SRO)	COMMUNICATIONS/CREW INTERACTION
Loss of RCS Makeup	S					X		X	
	R	X	X				X		
	B								
Loss of Automatic Pressurizer Pressure Control	S				X	X			
	R		X	X			X		
	B								
Failure of Pressurizer Spray Valve	S					X		X	
	R	X	X			X	X		
	B								
Loss of Automatic Pressurizer Level Control	S				X	X			
	R		X	X			X		
	B								
Progressive Failure of No. 1 Seal in RCP	S		X		X	X		X	
	R	X	X	X		X	X		
	B					X	X		
Failure of Steam Dump to Open	S				X	X			
	R		X			X	X		
	B								
Steam Generator Safety Valve Fails Open and Fails to Reseat	S				X	X		X	
	R	X	X		X	X	X		
	B					X	X		
Steam Generator Level Control Failure High/Low	S				X			X	X
	R	X	X	X			X		
	B						X		
Dropped Control Rod	S				X	X			X
	R		X	X		X	X		
	B					X	X		
Inoperable or Stuck Control Rod	S				X	X		X	
	R		X			X	X		
	B					X	X		

Table 6. An Example Event Description

Operating Sequence: Failure of Loop Temperature Instrumentation High/Low

NSSS/Type: Westinghouse/PWR

Initial PLant State: Reactor Controls in Automatic Power Level at About 75%, All Other Control Systems in Automatic

Sequence Initiator: Loop (X) Hot Leg RTD (Narrow Range) Fails High/Low

Important Plant Parameters: 1) RCS Temperature/Pressure, 2) Reactor Power, 3) PZR Level, 4) Rod Position

Progression of Operator Actions: See Flow Chart

Final Plant State: The reactor/turbine plant is at steady state. The temperature defeat switches (delta T and Tave) in loop (x) are defeated. The affected loop bistables for overtemperature/overpower delta T have been placed in the tripped condition.

Major Plant Systems: Rod Control, Reactor Proection and Control, RCS

Tolerance Range: The reactor/turbine plant is stable. The operator must place the rods in manual to mitigate the casualty. The bistables should be placed in the tripped position; the loop Tave and delta T inputs should be defeated.

Competencies Tested:

SRO - Compliance/Use of Technical Specifications
Supervisory Ability

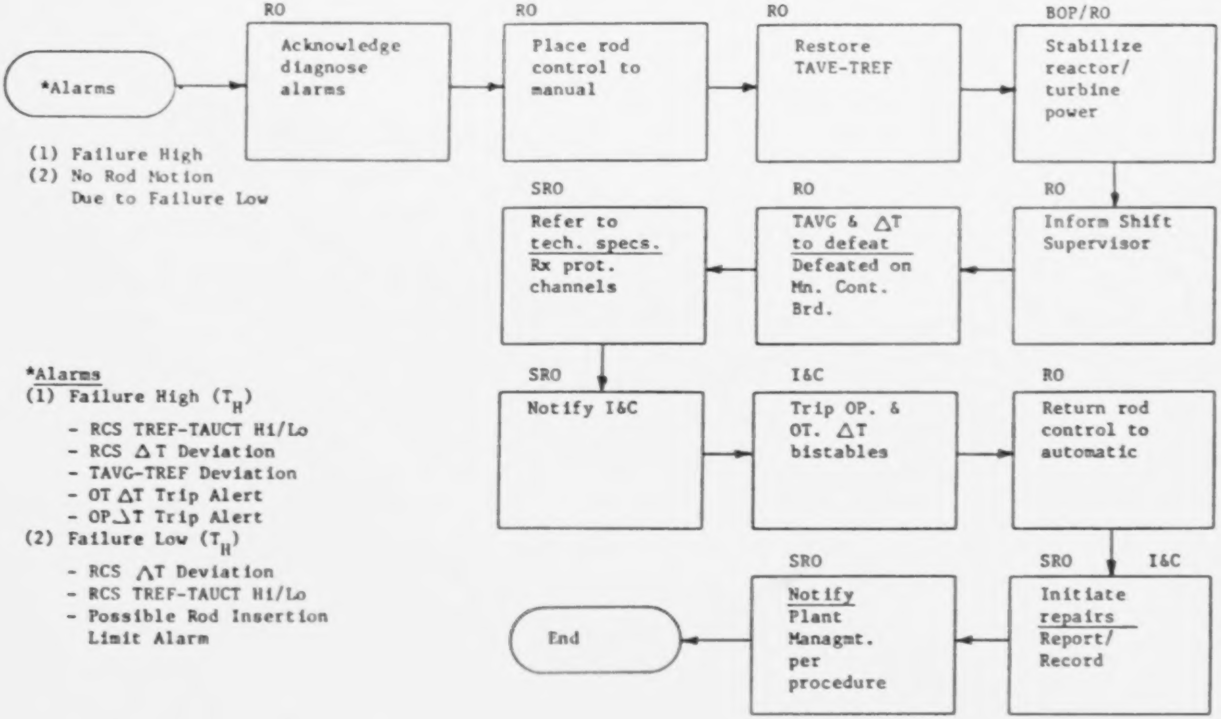
RO - Understanding/Interpretation of Annunciator/Alarm Signals
Diagnosis of Events/Conditions Based on Signals/Readings
Understanding of Instrument/System Response
Control Board Operation

BOP - Control Board Operation

NOTE: Most C-E units have similar system response, but operator response and corrective actions are different.

Table 6. Cont.

FAILURE OF LOOP TEMPERATURE INSTRUMENTATION HIGH/LOW
Progression of Operator Actions:


*Alarms
(1) Failure High
(2) No Rod Motion Due to Failure Low
RO
Acknowledge diagnose alarms
RO
Place rod control to manual
RO
Restore TAVE-TREF
BOP/RO
Stabilize reactor/ turbine power
RO
Inform Shift Supervisor
RO
TAVG & ΔT to defeat
Defeated on Mn. Cont. Brd.
SRO
Refer to tech. specs.
Rx prot. channels
SRO
Notify I&C
I&C
Trip OP. & OT. ΔT bistables
RO
Return rod control to automatic
SRO
I&C
Initiate repairs
Report/ Record
SRO
Notify
Plant Managmt. per procedure
End

*Alarms

(1) Failure High (T_H)

- RCS TREF-TAUCT Hi/Lo
- RCS ΔT Deviation
- TAVG-TREF Deviation
- OT ΔT Trip Alert
- OPΔT Trip Alert

(2) Failure Low (T_H)

- RCS ΔT Deviation
- RCS TREF-TAUCT Hi/Lo
- Possible Rod Insertion Limit Alarm

3. Initial Plant State--The operating status of the plant at the time the event starts. The initial plant state may be obtained either by use of the initial conditions input into the simulator computer, or by instructing the candidates to take the plant into the desired state.
4. Sequence Initiator--A brief description of the equipment failure(s) that causes the event.
5. Important Plant Parameters--Those plant parameters that should be monitored by candidates during the course of the event. Only parameters which are unique to the event are listed; parameters that are important in virtually every off-normal condition, such as primary system pressure, water levels, and reactor power, are not repeated in each description. The important plant parameters are intended to provide objective bases for use in candidate evaluations, including the ability to diagnose plant conditions, comply with procedures, and observe technical specification limits.
6. Progression of Operator Events--This is discussed below.
7. Major Plant Systems--Those plant systems that are uniquely affected by the event. The plant systems which are listed either experience the failure(s) or are used in mitigating the consequences of the failure(s).
8. Tolerance Range--The tolerance range of operator actions represents the bounds within which the candidates must respond before the technical limits are exceeded. Similar to "important plant parameters", tolerance ranges are intended to provide objective bases for use in candidate evaluation.
9. Final Plant State--The possible plant conditions by which a judgment can be made to end the event and move on to the next part of the scenario/examination. The event may be ended before this point is reached provided that enough information has been gathered to adequately assess candidate performance. However, if time permits, the event should be taken to the indicated final plant state.
10. Competencies Tested--This was discussed above.

Progression of Operator Actions

The progression of operator actions depicts in a flow chart manner the representative sequence(s) of expected immediate and subsequent candidate actions, including communication, that can be observed during the event. These flow charts are intended to be as generic as possible for a given reactor/vendor type. The flow charts indicate that, in some cases, there is more than one path which the event can take. The path taken will depend on the likely pertubations of the system, the decisions of the candidates, and/or choices made by the examiner. The objective of these multiple paths is to provide as much flexibility as possible, while retaining simplicity.

SCENARIO PREPARATION

Development of effective scenarios using the event descriptions is a five-step process:

1. Selection of the events.
2. Listing of the events.
3. Completion of the simulator scenario form.
4. Completion of the simulator administration form.
5. Completion of the competency checklist.

Step One: Selection of the Events

The event descriptions are intended to aid the examiner in selecting simulator events for compliance with the criteria described in ES-302. These criteria include:

1. Events requiring candidates to operate in normal evolutions, instrument failures, component failures, and major plant transients.
2. Events requiring candidates to operate under a range of conditions within each category as listed in item #1 above, such as degraded heat removal, degraded electrical power, containment challenges, and degraded pressure control.
3. Events that impact important safety systems such as the systems identified in PWR/BWR knowledge and ability catalogues, i.e., NUREGS-1122/1123 (Refs. 10 & 11).

4. Events that, together, will provide ample opportunity to evaluate each candidate on each relevant candidate competency.
5. Events that will complement and/or supplement information gained on the candidates during the written and oral examinations.

The events-by-competencies matrices should be used as an aid during the selection of events. They will be helpful in choosing a sufficient number of events and ensuring that the candidates demonstrate each of the applicable competencies over the course of the simulator exam. At a minimum, enough events should be selected so that each competency is demonstrated at least once more than once.

Step Two: Listing of the Events

Each exam scenario should present the candidate with a logical and realistic set of problems to which he/she is to respond. For example, component and instrument failures can be used as precursors to major casualties. This will fulfill two or three examination requirements while achieving scenario realism. A rough list of the events that are to be used in each scenario should be made. The events should be placed in a sequence which is logical and in which they will be initiated during the scenario.

Step Three: Completion of the Simulator Scenario Form

The simulator scenario form (ES-302, Attachment 3) provides the simulator operator with a set of instructions for entering initial conditions and malfunctions into the simulator computer. The information for this form is obtained from the event description cover sheets and simulator reference materials, particularly the initial conditions and the malfunction cause-and-effect descriptions. The cover sheets are useful for providing information on the initial plant state for a given event and the simulator malfunctions that may be used to initiate the event. The first item is to select the appropriate plant condition from the initial conditions menu. For example, if the event description specifies that the event should be initiated from high power, an initial condition for this power level may be selected from the menu, or a lower power level may be selected and the candidates directed to perform a power escalation. This will meet the requirements for a normal evolution or reactivity change, and a major casualty. The malfunctions to be run during the scenario, along with the elapsed time that the malfunction should be initiated, should then be included on the simulator scenario form.

Step Four: Completion of the Simulator Administration Form

The simulator administration form (ES-302, Attachment 5) should include the observable candidate behaviors for use in evaluating candidates. The progression of operator actions can be used as an aid in developing these expected actions/behaviors. This information should be compared to the plant specific procedures and technical specifications to ensure the appropriateness of the flow chart information for that facility.

Each action block in the flow charts indicates the candidate primarily responsible for the action. This is intended as a guide and may not be accurate for every situation. In general, the SRO is responsible for directing the actions of the RO and the BOP, communication with the auxiliary operator and other support personnel, and all administrative duties. The RO is primarily responsible for the reactor and reactor auxiliaries within easy reach of the reactor panel. The BOP is responsible for all plant secondary systems, electrical distribution, emergency core cooling systems, and process/area radiation monitoring. However, when the workload on one operator becomes excessive, assistance may be given by another operator. When an action is entered on the simulator administration form, the candidate responsible for the action is indicated in the "position" column.

Step Five: Completion of the Competency Checklist

After the first scenario has been drafted, the expected actions/ behaviors listed on the simulator administration form should be reviewed, along with the competencies tested which are identified on the event description cover sheet or the applicable events-by-competencies matrix, to determine which competencies should be addressed for each candidate. Subsequently, these competencies should be entered onto the competency checklist (ES-302, Attachment 8). If the checklist contains competencies that have not been checked off, the selection of events for the next scenarios should be chosen, in part, to evaluate these competencies.

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MAINTENANCE TRAINING - A MODERN NECESSITY

William Bushall

ABSTRACT

In recent years, there has been an increase in technically advanced systems and equipment and a need for highly skilled and knowledgeable maintenance technicians to maintain them. To implement an effective training program, training groups' and plant staffs' key to success must be cooperation and creativity. This paper deals with plant staff interface and how to effectively conduct performance-based training while holding the line on costs.

This paper includes cost effective and innovative measures to produce performance-based training for maintenance disciplines including:

- ° Using the plant staff as a resource as subject matter experts in the development and verification of training materials.
- ° Using the plant staff as a resource for the construction of training aids.
- ° Using salvage and surplus to produce high quality, low cost training aids.
- ° Using cutaways for better understanding of the theory of equipment operation.

These cost saving practices are currently being used at Gulf States Utilities' River Bend Nuclear Station.

V.A.4.2

MAINTENANCE TRAINING - A MODERN NECESSITY

The Plant Scrams -- the lights go out. Minutes seem like hours as Technicians scramble to restore the system. Operators are idle, as maintenance proceeds. The phone calls and questions begin -- What's the problem?", "When will we be back up?","This is costing us a fortune!"

The next day the inquisition is held. Why did it take so long to make the repairs and get the system back up? The Technicians were trained, weren't they!? Eyes turn to the Trainers. It seems that training on this particular equipment was planned last month but was cancelled due to "overhead", budget cuts, lack of manpower.

We know through data collected over the past few years that maintenance training is a necessity and that it has increased effectiveness in the field, reduced down time and saved money. This training is necessary due to modern advances in technology and complexities of the equipment and systems throughout the industry.

The man-hours and dollars expended on downtime and lost customer service certainly aren't considered overhead! How can you provide Maintenance Technicians the effective knowledge and performance training needed to troubleshoot and repair sophisticated equipment and systems AND stay within your training budget? The answer:

- USING THE PLANT STAFF, AS A RESOURCE FOR SUBJECT MATTER EXPERTS, IN THE DEVELOPMENT AND VERIFICATION OF TRAINING MATERIALS.
- USING THE PLANT STAFF AS A RESOURCE FOR THE CONSTRUCTION OF TRAINING AIDS.
- USING SALVAGE AND SURPLUS TO PRODUCE HIGH QUALITY, LOW COST TRAINING AIDS.
- USING CUTAWAYS FOR BETTER UNDERSTANDING OF THE THEORY OF EQUIPMENT OPERATION.

Who better to obtain information from, for training materials development, than the plant system experts; both engineering or technician types who have first hand experience of the system or component. This is a valuable resource, as no one person can be an expert on all components or systems, due to modern complexities. These experts do not have the time to be training instructors. By utilizing them, as a source of information and verification, many hidden problems may be discovered and a better understanding of the systems may be included in the training material for presentation in the classroom.

Another factor to be considered is that many companies rely heavily on vendors, in many cases this is very good, but you must realize that their knowledge and expertise is on a component and not on the plant specific system application in which the component is installed. We have all found manufacturer's literature to be vague and generic, since it is written for multiple applications. The plant staff subject matter expert, "SME", is familiar with the plant specific application and can provide more pertinent information for your training material.

Direct interface between training and plant staff should be on a "one on one" basis between the SME and the instructor, which is generally volunteered without hesitation. For verification of both vendor and in-house training, and to add operating experiences and ensure correct information dissemination, class attendees should be comprised of experienced personnel, as well as non-experienced personnel. Consider also these SME's as guest lecturers and material developers for lesson plans on the more complex equipment and systems, which are in use. Do not neglect considering operations personnel for either development or lectures, this gives another point of view of systems and operating experiences, especially in regard to troubleshooting and analysis.

Sources for seminars, outside of plant staff, may be provided "free for the asking" from local dealers or distributors. These seminars are excellent for that extra information on speciality items, eg; heatshrinks, fittings, fuses, bearings, seals, and consumable items.

After training material has been developed to present theory and knowledge concepts to the trainee; the next step would be to produce or procure equipment and material for the performance portion of the training.

Remembering we have a very limited budget, the closest source of supplies would be the plant itself.

Plant staff personnel can produce needed training aids, such as mockups and stands from salvaged, damaged out of spec, QA rejects or scrapped equipment and materials; also to be considered is material considered excess, or from decommissioned or canceled units.

Even though plant staff manpower is limited at times, training is a continuous program. There are slack work periods in the plant, during which cutaway machining, welding and fabrication of training aids can be accomplished. Utilitzation of the trainees to build or erect the training aids also serves a dual purpose; this exercise provides knowledge of the actual construction of the training aid and gives the trainee practical performance training.

The use of salvaged or surplus material as a training aid requires nothing more than an understanding of the company's procurement and accounting procedures. Gaining this understanding may be a complicated and time consuming process, but the reward is procurement of inexpensive training aids that are plant specific. Understanding procurement and accounting procedures enables those involved to become more familiar with these procedures and policies and helps them to recognize what items may be available within their own companies as well as from other sources.

Utilization of existing materials and facilities only takes a few moments of time. Now have you thought of the easiest places to obtain materials? These are the dump, bone yards, junk pile or garbage heap, all you have to do is go and look you never know; and how about the manufacturer, local distributors or agents, who assisted during construction; those that have contracts with the plant will usually donate scraps or sample items for training. These are also very good sources of information as well for providing short seminars or demonstrations.

Cutaways are an invaluable training aid. They provide a better understanding of equipment operation, especially for complicated and multi-component constructed equipment; by showing the physical internal construction of the component, eg, fuel injectors, multi-part valves, gear boxes and pumps. Cutaways allow the technician to actually see how the theoretical concept of the item is utilized in that application.

All of these training aids help the technician to actually see, feel and perform specific tasks associated with their job in an effort to increase their effectiveness in the field in making quick and accurate repairs.

By utilizing the company's assets which are sometimes overlooked or forgotten, this training may be completed under budget.

Attached is a list of items, procured through the methods described in this paper, with approximate savings incurred.

I would like to acknowledge the assistance given by Leroy East, Chuck Campbell and Jimmy Allen for their effort in the identification and procurement of many of the listed training aids.

V.A.4.6

ATTACHMENT

EQUIPMENT PROCURED	ESTIMATED SAVINGS TO TRAINING
480V Switchgear with breaker and relays	$ 3,000.00
4160V Switchgear with relays class 1E lost QA due to damage	6,000.00
Class 1E battery cells in hot storage (on loan)	10,000.00
Welder and rod oven	2,000.00
200 hp motor & pump assembly	2,000.00
25 hp motor	500.00
Cummings Diesel Fire Pump complete	15,000.00
Control Rod Drive Mechanism and Hydraulic Power Skid	50,000.00
Vertical multi-stage pump	500.00
Small Air Compressor	500.00
Recirc Pump Motor Stand and Seal Stuffing Box w/tools	60,000.00
Various small valves	500.00
EMD Diesel Fuel Injectors	2,000.00
Pipe threader, Drill press	1,000.00
Out of Cal M&TE, Recorders, Misc Transmitters, used trip unit cards	5,000.00
1200 HP Vertical Motor	60,000.00
	$218,000.00
EQUIPMENT IN PROCESS OF BEING PROCURED	
SMB000 MOV's	5,000.00
Nash Vacuum Pump	25,000.00
Safety Relief Valve	10,000.00
Testable Check Valve	5,000.00
	45,000.00
ITEMS BUILT BY PLANT STAFF PERSONNEL	
Alignment mockups	2,000.00
Cutaway Fuel Injectors	1,000.00
Valve Cutaways	1,000.00
Control Rod Drive Tools	3,000.00
	$ 7,000.00
TOTAL ESTIMATED SAVINGS	$270,000.00

The following paper was not received in time to be published in the proceedings. Space is provided below for notes.

Maintenance Training: An Historical Perspective........................
George Shaw, Rochester Gas and Electric

NOTES:

EFFECTIVE TRAINING FOR THE NUCLEAR FIELD USING COMPUTERS

S. E. Forrer
G. J. Dickelman

ABSTRACT

Since the introduction of microcomputers there have been training applications in many disciplines; the nuclear field is no exception. Because of the use of computers in training, a variety of development tools known as authoring systems have emerged for creating instruction. There is clearly a connection between the capabilities of the authoring systems and the effectiveness of the training they produce. Unfortunately, it is too often the case that the limitations of the authoring systems drive the instructional design of the programs they produce. The result is very poor or limited instruction.

This paper deals with the instructional design of good nuclear training material and its implications for features that must exist in an authoring system. The paper looks at four categories: visual displays, sound, interaction, and realism. Each category is examined from the standpoint of training program content and instructional design, then the authoring system features that are required to support each category are determined. Consideration is given not only to the list of features, but also to their integration, ease of use, and flexibility.

The reader will ultimately be provided with a good sense of which features and characteristics must exist in an authoring system in order to produce effective nuclear training material. In particular, the reader will find useful information to apply to the process of authoring system selection.

INTRODUCTION

Computers have been used in education and training for many years. It would seem to follow that the task of adopting computers for your training material would be an easy one. This might be the case if computer technology grew at a relatively slow rate, but this is not the case. Since 1981 there have been a tremendous number of changes. What follows are instructional tools and techniques which take advantage of the technological changes. The result is an environment which is extremely rich in alternatives for creating, delivering, and managing instruction on the computer.

Instructional technology consists of instructional strategies and procedures, software, and hardware. The primary focus of this paper is on the software and how it can support your designs--those which support training in the nuclear field. The name given to software products which support the lesson creation process is authoring system. The following sections define and discuss this term, then determine features which must exist in an authoring system in order to support effective nuclear training material. While the ideas discussed here are applicable to most computer systems, the focus will be primarily on the microcomputer since it currently has the widest application in training.

AUTHORING SYSTEMS - WHAT ARE THEY?

Loosely speaking, an authoring system is a collection of software tools which assists in the creation, delivery, and management of computer-based instruction. While general purpose computer languages (BASIC, FORTRAN, PASCAL, C) can be used to create instruction it is recognized that they lack the specialization for instructional design; it is tedious, time consuming, and therefore costly to create instruction using general purpose languages.

In particular, an authoring system provides the means to create display frames or screens, link the frames in some order, provide the opportunity for student interaction, process and respond to student input, and manage the process. The degree to which programming is necessary varies from system to system, but it is generally the case that the features they provide substantially reduce the time and effort associated with creating instruction. Table 1 gives a general list of features which define an authoring system.

Table 1. General Features of an Authoring System

- Frame Creation (Text & Graphics Editors)
- Frame Logic (Branching)
- Question and Answer Creation
- Interaction
- Lesson Debugging
- Student Data Storage
- Program Management

Language System Versus Menu-Driven System

There are two opposing designs for authoring systems: language systems versus menu-driven systems. Language systems are programming languages which have the specialty items of Table 1 built in; menu-driven systems, as the name implies, require no programming. Each approach has its merits and pitfalls.

Generally speaking, menu-driven systems are easy to use but are restrictive because, without programming, you cannot make use of many of the computer's capabilities. Language systems are rich with capabilities but are more complicated and time consuming to use because programming is involved. A greater level of computer expertise is required to use language systems than menu-driven systems, but the end product can generally be more sophisticated if language features are utilized to created certain effects.

An emerging alternative to these approaches is the hybrid authoring system which incorporates the best of both worlds. That is, it has a variety of levels at which it may be used. The "novice" level is primarily a menu-driven system, but "expert" levels allow the user to access a language (or languages) for applications in which the menus do not provide sufficient alternatives. The best hybrid system will adapt to your level of sophistication to the extent that you can "drop out" to a general purpose language for the most demanding effects while still using menu-driven editors to perform routine tasks. Figure 1 illustrates the distinction between menu-driven and language authoring systems and their relationship to the hybrid system.

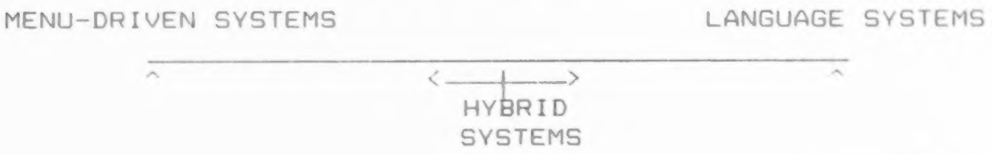

Figure 1: Menu-Driven, Language, and Hybrid Authoring Systems

V.A.6.5

AUTHORING SYSTEMS FOR THE NUCLEAR FIELD

In order to select the proper authoring tool for any training application you must first examine the content domain and instructional design of the program. It is too often the case that training organizations attempt to select the "best" authoring system for computer-based programs by comparing authoring systems rather than by considering the programs they wish to deliver by computer. The result of this approach, unfortunately, is often the selection of an authoring system which restricts, or even dictates, the instructional design of computer-based programs. (By definition, a system is not the universe and will therefore contain limitations; choosing the wrong set of limitations can be disastrous to instructional design.)

Training programs for the nuclear field are numerous and vary widely in content and design. The ultimate mission of the training, however, is the safe operation of nuclear generating stations. Whether a program trains operators on the use of safety injection systems, how to safely approach criticality, or emergency procedures in the case of a steam generator tube rupture, there are specific standards that a computer-based program must meet in order to satisfy the mission. In particular the programs must create meaningful visual displays, in some cases reproduce actual sound, provide meaningful interaction, and must be realistic in content. The following sections define precisely what these mean in terms of authoring system capabilities.

V.A.6.6

Visual Displays

Nuclear training material is demanding with regard to visual displays. When an operator first learns a mechanical or electrical system, he or she must become familiar with conceptual line drawings (P&IDs) as well as identify physical panels and displays. Authoring software must therefore provide the capability to produce graphics with good resolution at a reasonable cost in terms of time and effort. Ideally, the authoring system should be flexible enough to import graphics created with other popular graphics programs and provide the means to modify the imported graphics.

The authoring system must allow for the creation and display of custom text characters. Trainers in the nuclear field are routinely frustrated by the absence of the industry-standard characters used in nuclear science (reactivity, delayed neutron fraction, chemical symbols, etc.) on microcomputer displays and word processing packages. The graphics mode of all standard microcomputers is fully capable of displaying custom characters and fonts and allowing for their creation via special software programs. At a minimum, the authoring system you select for nuclear training applications should support custom characters and fonts.

The authoring system must also allow for the combination of text and graphics. That is, text and graphics are separate items as far as most computer hardware is concerned. Combining the two on the same display requires special handling by the authoring software; not every system will do this. In fact, many authoring systems cannot produce or display pixel-based graphics at all. (Beware of the system which boasts "full attribute character graphics" as this is not graphics at all but simply special text characters. You cannot, for example, draw a diagonal line or an arc with such a system.)

If the system supports graphics there are additional questions to ask. Does your training program require animation, and if so, does the authoring system support animation? Many systems will only support static displays, and sometimes at great cost in terms of computer disk space. In order to produce the dynamic displays and simulations that are so crucial in nuclear training, the authoring system must provide animation. In the ideal case, the system will have the ability to do both: import static displays, then allow you to enhance them in a variety of ways, including the addition of animation.

In addition to text and graphics, nuclear training applications often require video. Many authoring systems will drive a videotape or videodisc player via the computer. Videodiscs have the advantage of relatively quick random access over videotape and therefore lend themselves better to interactive training. The disadvantage, however, is a significant increase in cost to produce such a computer-based program.

There are several important considerations regarding the video-based authoring system, the most important being whether or not computer generated text and graphics can be displayed simultaneously with the video image. Generally, the electronic video signal and the computer text and graphics signal are different types (NTSC or composite versus RGB). At the low end, separate monitors are required for each. Special monitors are now available which determine the nature of the incoming signal and display images accordingly--but they may not show video and computer text/graphics simultaneously.

Authoring systems which incorporate video and provide the computer graphics/text overlay capability (simultaneous display) are available, but be aware that hardware costs escalate for this capability. Special video and graphics adapter boards and monitors are necessary to convert signals and provide the overlay capability. These hardware costs start at several thousand dollars.

The degree of friendliness of authoring software with regard to video management is extremely important. Some systems allow you to link with almost any video-driver software program and are therefore not tied to specific hardware configurations. This adds a degree of complexity, however, to program development. Other systems support specific hardware configurations and have many editing features built in. A caveat applies here: examine the requirements of the proposed training program before making a software decision.

Table 2 summarizes authoring system features for visual display.

Table 2. Authoring System Support For Visual Displays

Create, Edit, and Display...

- Text
- Graphics
- Animation
- Text over graphics
- Custom characters/fonts

Import, edit, and display graphics

Support for...

- Videotape or disc
- Text/graphics overlay

Sound

There are many training applications for which sound is important. At the low end an occasional "beep" from the computer can provide useful feedback. At the opposite extreme, the reproduction of control room enunciators might be the best approach in some pre-simulator or refresher training.

At the very least the authoring system should allow you to program the computer's speaker for the simple applications. This is often done via "music" editors that are sometimes part of the graphics package. Be aware that many systems do not have this capability, as simple as it may seem.

There are many options available for reproducing recorded sound, and those options are growing rapidly. The simplest (but seldom used) method is to drive a tape recorder. Some authoring systems will allow you to link to software which will drive a recorder. An alternative is to use an audio track of a video tape or videodisc. There are problems, however, associated with providing sound over still images using this option. Digitized sound is also an option, but it generally takes a relatively massive amount of disk space to store short segments of audio.

Compact disc technology (CD-ROM and CDI) is emerging as the solution to the storage space problem, but adopting it introduces new hardware and software options. At the time of this writing few authoring systems fully support compact disc technology. If you must use it, it is wise to choose hardware carefully and to select an authoring system that can easily import digitized audio files and play them at any time in a lesson.

Table 3 summarizes authoring system features associated with sound.

Table 3. Authoring System Support For Sound

Program the computer's speaker ("beeps" and music)
Drive tape recorder
Play audio track of video tape or disc
Digitized sound
Compact disc (CD-ROM or CDI)

Interaction

Without meaningful interaction there is perhaps little need for using computers in training. While traditional computer-based training cannot reproduce the complex interactions that take place in training environments such as the classroom, the simulator, or on-the-job training, there are clearly minimum interaction requirements for computer-based training programs to be meaningful. "The computer" must have the ability to accept and process more than mere multiple choice responses if the safety mission of nuclear training is to be satisfied. Moreover, the computer must be able to provide feedback based on the judgment of a student's response. In authoring system terms, it must have the ability to provide sophisticated, conditional answer processing and branching.

It is at the level of answer judging and branching that language features should begin to appear in an authoring system. That is, some primitive rules of inference are required if interaction is to remotely resemble human interaction. This implies that there must be some "if...then..." capability built into the system. At the high end, this means an artificial intelligence inference engine; but this is not what most authoring systems support. Rather, a language is embedded within the authoring system which allows you to say, "If the answer is close to 'source range detectors' then judge it correctly and present frame #32 as feedback" and the like. It should also have a simple but comprehensive means of specifying which answers are close to "source range detectors." For example, key word searches, spelling checks, wild cards, string parsing and concatenation should all be done without significant effort on the part of the author. There should be few or no restrictions on the number of paths to which to branch from a given interaction point. In addition, backward branching should also be possible.

The judgment of interaction other than keyboard input must also be possible. At a minimum the authoring system must provide some sort of pointing device (via cursor keys, mouse, light pen, etc.) and the ability to define "touch sensitive" areas of the screen. This provides for training in which a mechanical system's components must be identified, for example. At a more sophisticated level, the authoring system should allow the trainee to manipulate portions of a graphic display to simulate the movement of switches and dials or the performance of maintenance operations in which assembly and disassembly is important.

You will find that the ability of authoring systems to provide for interactive training varies from the barely capable to the most sophisticated. For most nuclear applications, those systems which approach the most sophisticated are preferred.

Table 4 summarizes authoring system features associated with interaction.

Table 4. Authoring System Support For Interaction

Multiple input on a single screen
Conditional answer judging
Key word search, spelling check, wild cards
Forward & backward branching
Conditional branching
Pointing device(s) & "touch-sensitive " screen areas
Manipulate screen areas

Realism

Realism in the nuclear training environment means, at the least, the use of actual plant operating parameters. Whether the training application is on a routine plant-related calculation or involves complex simulation, real information must be used. Incorporating such realism into computer-based instruction should require the least amount of by-hand data collection and program management. That is, computers are used to create and maintain databases of many classes of information. Plant operating parameters, parts inventory, operating history, emergency procedures, and many other bits of information are routinely stored in databases. The authoring system should be the vehicle by which this information is tapped and kept up to date in training programs.

What this means is that the authoring system must have the ability to access external databases, select relevant information from them, and use this information in lesson material. While this process may seem rather demanding, it can be broken into simple steps: searching databases, writing selected information to files, reading external files, and assigning information found in the files to authoring system variables. If the authoring system and database system in combination can perform these steps, then the process is possible. The process guarantees that training programs are realistic and up-to-date (at least as far as the databases are up-to-date). Moreover, it removes a level of error associated with human retrieval of realistic data and incorporating it into training material by hand.

In the category of realism, as defined above, there are few authoring systems which provide such sophistication. In fact, most authoring systems do not provide user-definable variables and therefore cannot even pass data from frame to frame, let alone from external application to the lesson and vice-versa. Some systems will execute external applications, but do not have the ability to pass data back and forth or read and write data files.

Nuclear trainers should carefully consider realism in their training programs. It is not a simple matter to search out the required features within authoring systems; it is perhaps even more difficult to find a working demonstration of such features. If you are tasked with authoring systems selection, it is well worth the time and effort to determine which system(s) contain the features which support realism.

Table 5 summarizes authoring system features associated with realism.

Table 5. Authoring System Support For Realism

Author-definable variables
Access external databases
Pass data between lessons and databases
Read and write data files

SUMMARY AND CONCLUSION

The mission of nuclear training places stringent standards on the content and design of its programs. Computers provide an attractive means of presenting instruction, but must meet the rigorous standards imposed on all presentation media. As such, the tools for creating computer-based instruction must be carefully scrutinized for their capabilities to produce training material which satisfies the standards.

Authoring systems for computer-based instruction are numerous and diverse in their capabilites. Many do not support features capable of creating instruction to nuclear field standards. It is incumbent upon trainers in this field to carefully examine both the content and instructional design of programs they wish to deliver via computer, and then embark on the authoring system evaluation and selection process. This is different than selecting the "best" authoring system by comparing authoring systems. An authoring system is not a single tool but a collection of tools; it is only after the job is understood that the right collection of tools can be selected.

A list of articles and publications related to the authoring systems evaluation process is attached to assist those who are facing the process.

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COMPUTER BASED TRAINING FOR NPP PERSONNEL (INTERACTIVE COMMUNICATION SYSTEMS AND FUNCTIONAL TRAINERS)

H.-D. Martin

ABSTRACT

KWU as a manufacturer of thermal and nuclear power plants has extensive customer training obligations within its power plant contracts. In this respect KWU has gained large experience in training of personnel, in the production of training material including video tapes and in the design of simulators.

KWU developed interactive communication systems (ICS) for training and retraining purposes with a personnel computer operating a video disc player on which video instruction is stored. The training program is edited with the help of a self developed editing system which enables the author to easily enter his instructions into the computer. Another special application is designed for a motoric repetition and testing of interlocks in complex systems, where the operating staff has to recheck its knowledge in short intervals. Further mathematical modelling of system behaviour is performed through simple simulation procedures in order to intensify the interaction between the trainee and the training system. ICS enables the plant management to better monitor the performance of its personnel through computerized training results and helps to save training manpower.

German NPPs differ very much from other designs with respect to a more complex and integrated reactor control system and an additional reactor limitation system. Simulators for such plants therefore have also to simulate these systems. KWU developed a "Functional Trainer" (FT) which is a replica of the primary system, the auxiliary systems linked to it and the associated control, limitation and protection systems including the influences of the turbine operation and control. It calls for approximately 30 % of the investment cost and can cover almost 80 % of the training program of a full scope simulator.

Another approach is the "Nuclear Plant Analyzer" (NPA) which provides graphical displays and systems status on coloured CRTs coming from design codes run on a mainframe computer via telephone line.

KWU'S TRAINING PHILOSOPHY AND STRUCTURE

KWU's function as a manufacturer of nuclear power plants in the Federal Republic of Germany differs significantly from that of foreign manufacturers. This is mainly due to the fact that KWU is a turnkey contractor. From the initial fuel loading of the reactor until handover to the operating company, KWU is a joint applicant for and holder of the licence under the terms of the West German Atomic Energy Act. In addition, KWU is responsible for the plant-oriented training of the customer's staff and provides a large variety of training services for German and foreign customers.

KWU developed a modular training system with which it is possible to take into account the differing requirements of various projects and customers, without having to work out a new program each time. The essential parts of the training system are basic training and specialist training. Basic training comprises basic technical courses up to instructor courses.

Specialist training encompasses six groups of training modules. The first group consists of technical system and plant courses, the second group is similarly structured, and provides simulator courses. All the theoretical courses for specialists are included in the third group; the fourth and fifth groups cover practical on-the-job courses. And the sixth and last group comprises the phase of familiarization with the customer's own plant during erection and commissioning.

The training program for NPPs in the FRG can be divided into five steps (Fig. 1)

- The preparatory phase with basic theoretical training
- The practical training on-the-job in similar instal-

lations
- The plant related special training
- The simulator training
- The commissioning of the own plant.

The basic theoretical training consists normally of a 3 months course in a research center, at a technical university or in a utility owned school and a 6 weeks systems introductory course at KWU. Practical training is organized by the utilities themselves while the plant related special training is provided by KWU.

Before KWU offers the customer a training program for the various groups of personnel, an optimum organization of the plant, with job descriptions and job specifications, is proposed. This is of particular interest to foreign customers. The personnel to be trained is categorized by qualifications. By means of this procedure and with the aid of the modular training system, standardized training courses can be compiled from the individual training modules.

Each participant of a theoretical course receives accompanying training material for each topic with text, data and graphics. Lectures are held in the morning; the afternoons are reserved for seminars. At the end, the participants in the seminars present their results before the whole class.

At the end of each subject section, a colloquium is held, in which an expert answers questions that are still open, and gives a final survey. At regular intervals, written tests are given; part of them consist of multiple-choice questions, which can be evaluated quickly with the help of a minicomputer. At the end of a training session, which does not normally last longer than two months, a formal intermediate examination is held.

The training programs developed by KWU are part of the programs which West German operators must submit to the regulatory agency in order to obtain an operating licence. The intermediate examinations of the plant courses are approved by the authority as written parts of the licensing exam. In part, representatives of authorities observe or participate in KWU courses.

Simulator training for German utility personnel normally is within the scope of the utility run simulator training center. However, since 1983 KWU is heavily involved both in simulator initial and retraining activities for the German preconvoy and convoy plants.

For all this KWU disposes of a customer training organization with studio facilities for professional video and film production, the manufacture of training material and specialists for the design of training programs and individual courses as well as the instructors for the various special subjects.

INTERACTIVE COMMUNICATION SYSTEMS

For the purpose of individual training and retraining KWU developed an interactive communication system (ICS, Fig. 2).

ICS is a media where the flow of information is no one way street from the media to the trainee. The success of the trainee in digesting the information can easily be monitored and thus is kept evident compared to other media.

ICS consists of a training course, structured with the help of a table of contents and various types of test questions after each section with additional instructions or branching.

The trainee can start any section through the table of contents or in defining a subject word. In this case, the computer starts the program on video disc at this section where the subject word is explained. The final test is randomly organized so that never the same test sequence is provided. The trainee gets an immediate feedback on his performance after each question. He can delete individual questions or he can decide to answer them later. At the end he gets his personal result and an indication of those sections of the lesson where he gave wrong answers.

For those subjects where the real working environment has to be shown, i. e. repair manipulations etc. or where complex technological phenomenon can only be displayed by animation a video disc is used which is linked to the PC via an especially developed video mixing equipment. In the case of repetition of logical conditions of plant systems and procedures as part of the retraining program only a motoric test is necessary. This is performed by the PC itself without requiring video instructions, the PC generating the P&ID directly on screen.

An editor software package was developed which requires no programming knowledge and is easy to use. The user can design training courses, divided into sections by himself following the program menu. After the sections he integrates test questions for which the editor provides various types of question formats.

Text overlays to video images are possible as well as area assignment or user assignments on screen. Modification of inputs are easy to make as well as the addressing of images. No time code conversion is required.

Also small simulation applications are included in the system in order to make the training more practical oriented.

The video material is produced in the KWU owned studio, mastering is done outside. The hardware used consists of a Siemens PC compatible with IBM standard, a standard video disc player and the electronic video mixing equipment. If a utility wishes to document the training result or individual screens a printer can be added. All this equipment is integrated in the KWU Teach Tower.

NUCLEAR PLANT ANALYZER

The KWU "Nuclear Plant Analyzer" (NPA) is a real time engineering simulator based on the KWU computer programs used in plant transient analysis and licensing.

The primary objective is to promote the understanding of complex technical and physical processes of a NPP during malfunctions or malfunction combinations.

This has been achieved by the application of the transient code NLOOP and operator interaction including all simulator functions normally available in training simulators. The mainframe computer in the KWU computing center drives four colour graphic displays controlled by a dedicated graphic computer by telecommunication via telephone.

No control room is available since emphasis is put on the graphical display of variables and system status (Fig 3).

Three types of pictures are provided:

- semigraphic pictures (symbolic plant diagrams e. g.) with process data as alphanumeric data, analog bars (water level e. g.) and graphic symbols (pressurized spraying e. g.)
- curve pictures containing up to 6 axes with up to 6 curves each (trend curves for power, mass flows etc.)

- lists with alpha-numeric data (annunciations, operator interactions etc.)

Some pictures contain fields where user defined variables can be displayed. The assignment of a specific picture to a display is at the liberty of the operator.

One version of the NPA based on the code NLOOP is in operation for KWU 1300 MW Standard PWR plants. It can be adapted to suit other PWR plants by some reprogramming to meet the individual demands especially in the field of control and instrumentation.

The objective of the NPA is to be used for training of higher level, managerial NPP personnel, not directly involved in shift operation. Another application is to be used for transient analysis giving a prompt feedback even if parameters are changed. Thus it can also be used as a means of malfunctions logistics and to assist the technical support center in case of emergencies.

FUNCTIONAL TRAINER

During 5500 h of training of shift personnel on a full scope simulator both for initial training and retraining purposes KWU has run an evaluation program about the amount of utilization of the different areas of the simulator control room. The analysis lead to the conclusion that up to 80 % of the total training can be provided by representing only 30 % of the full scope control room.

This is mainly due to the fact that German NPPs in addition to other designs have a special reactor limitation system separate from the reactor control system and the protection system. It is designed on the basis of the same safety standards as the protection system, i. e.

4 channels and initiates automatic actions to locally and globally protect the core and the primary system in case of transients before the protection systems is activated.

The training of these complex systems therefore plays an important part in the overall simulator training program although it requires only a part of the simulator. The design of this "Functional Trainer" (FT) calls for the detailed simulation and representation of the primary system, the auxiliary systems directly connected like emergency core cooling, volume control or extra borating system. The secondary system is simulated as a closed cycle with detailed representation of life steam, feedwater supply and emergency feed water.

Other systems are represented by replacement simulation. Redundant trains, i. e. ECCS are totally simulated, however, only 1 of 4 trains is represented in the control room with additional position switches for the indication of the other parallel trains.

The FT also contains a high resolution computer aided process information system (PRINS) for the display of multifunctional diagrams, trend indications or system status displays (Fig. 4). The FT uses two SEL computers of the 32 series which are connected with the control room interface via fiber optics.

The FT is mainly used for practical exercises and familiarization with the reactor control systems, limitation systems, turbine controls and reactor protection system. This requires a scope of simulation which allows load follow operation, 3 loop operation, hot start-up after reactor or turbine trip, load rejection to inplant supply and total start-up and shut-down.

It goes without saying that the FT can also be used for design-objective-oriented strategy and behaviour training.

The instructor can program exercises in parallel with the training session by defining initial conditions, malfunctions or degradations, trend recorder or CRT display parameters a.s.o.

The FT is also used for the further development of the computer aided process information system (PRINS) for new plants. If installed at site the FT can be linked in parallel to the real plant via the data acquisition computers which normally feed the PRINS processing computer. Thus it can be used as an "On-line Predictive Analyzing and Learning System" (OPAL).

FIGURE LIST

Caption

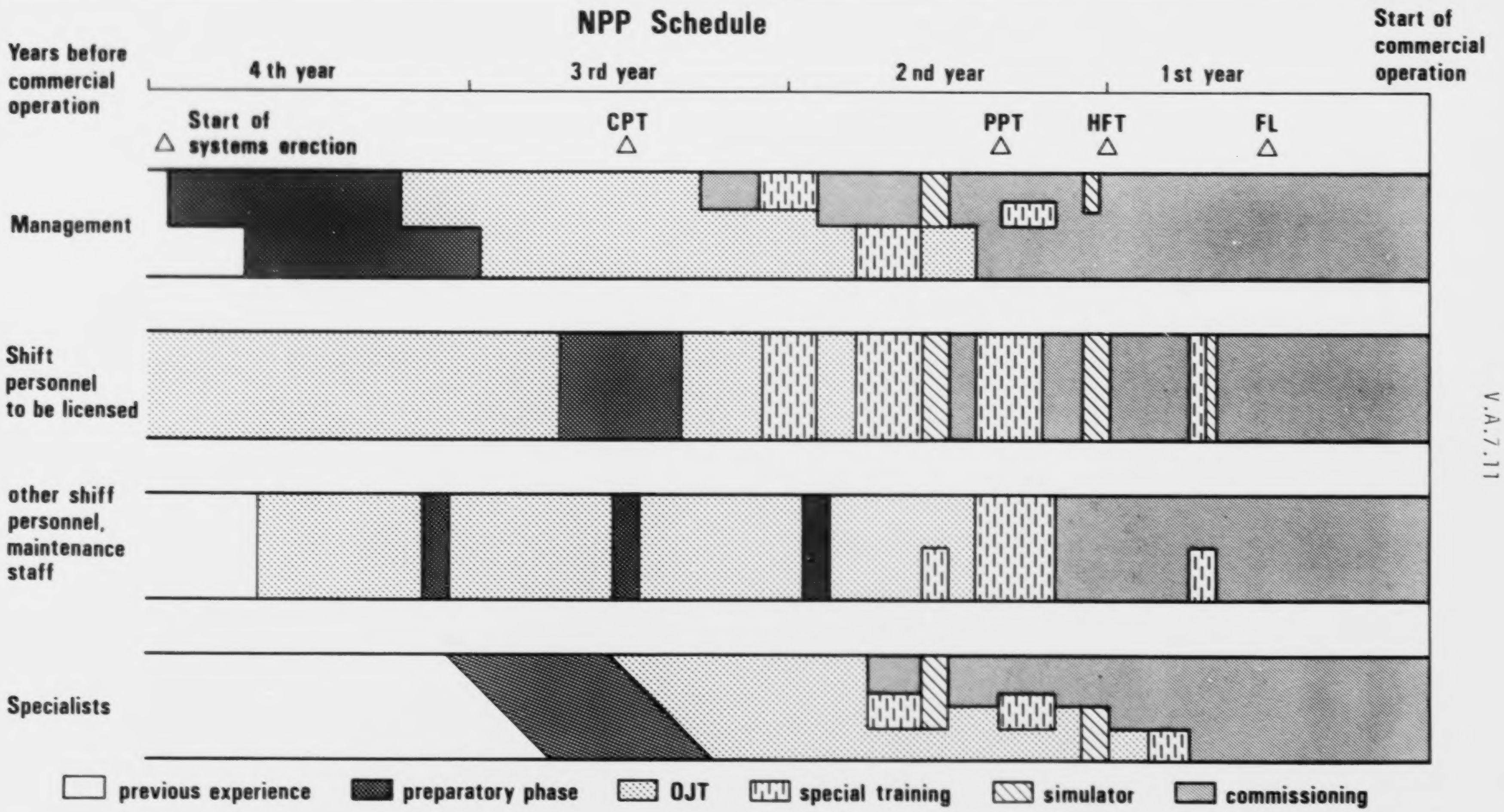
Fig. 1. Training Program for NPP Personnel in the FRG

Fig. 2. KWU ICS Teach Tower

Fig. 3. KWU Nuclear Plant Analyzer

Fig. 4. KWU Functional Trainer

KWU



V.A.7.11

Fig. 1

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VZS6 2/87

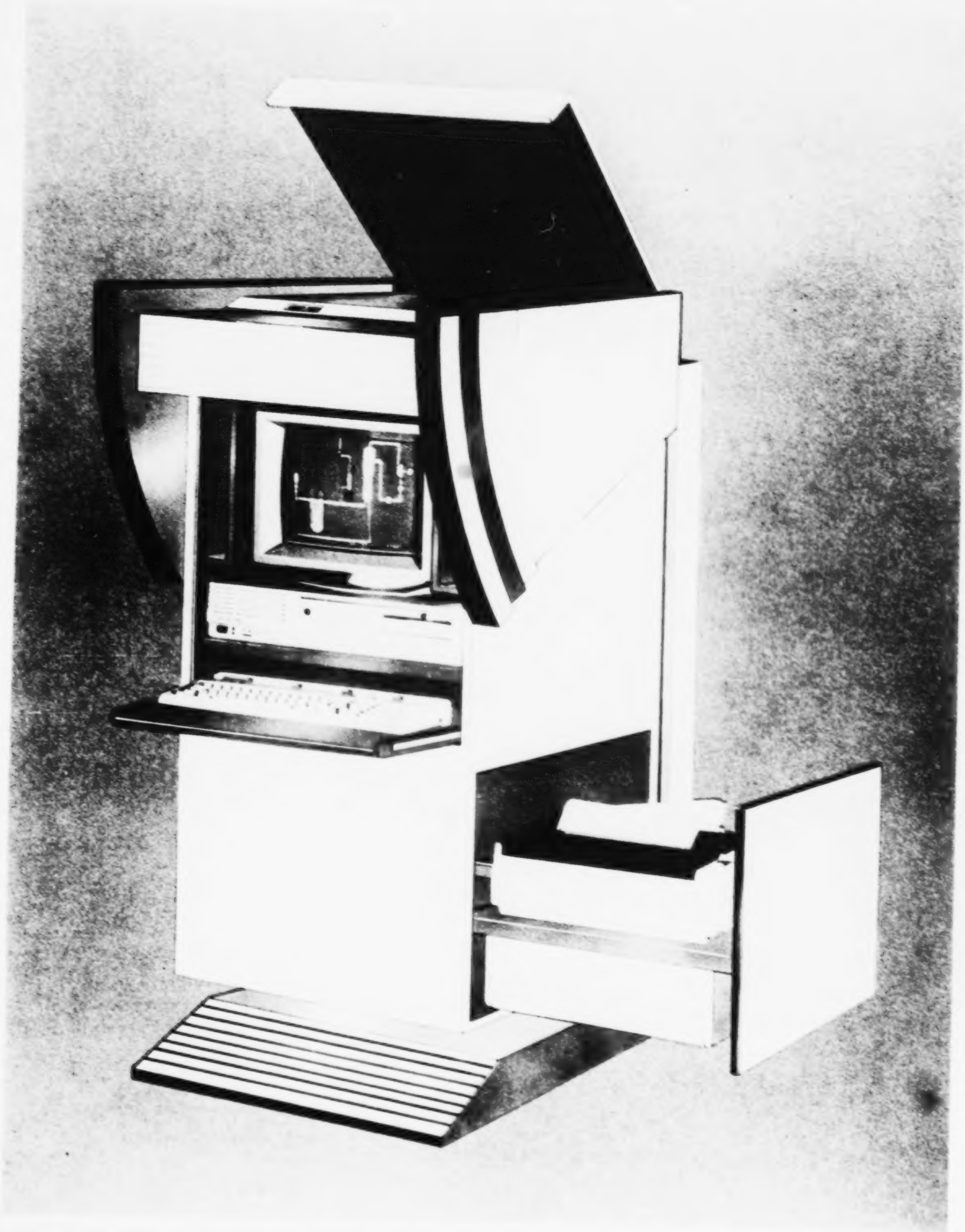

Fig. 2

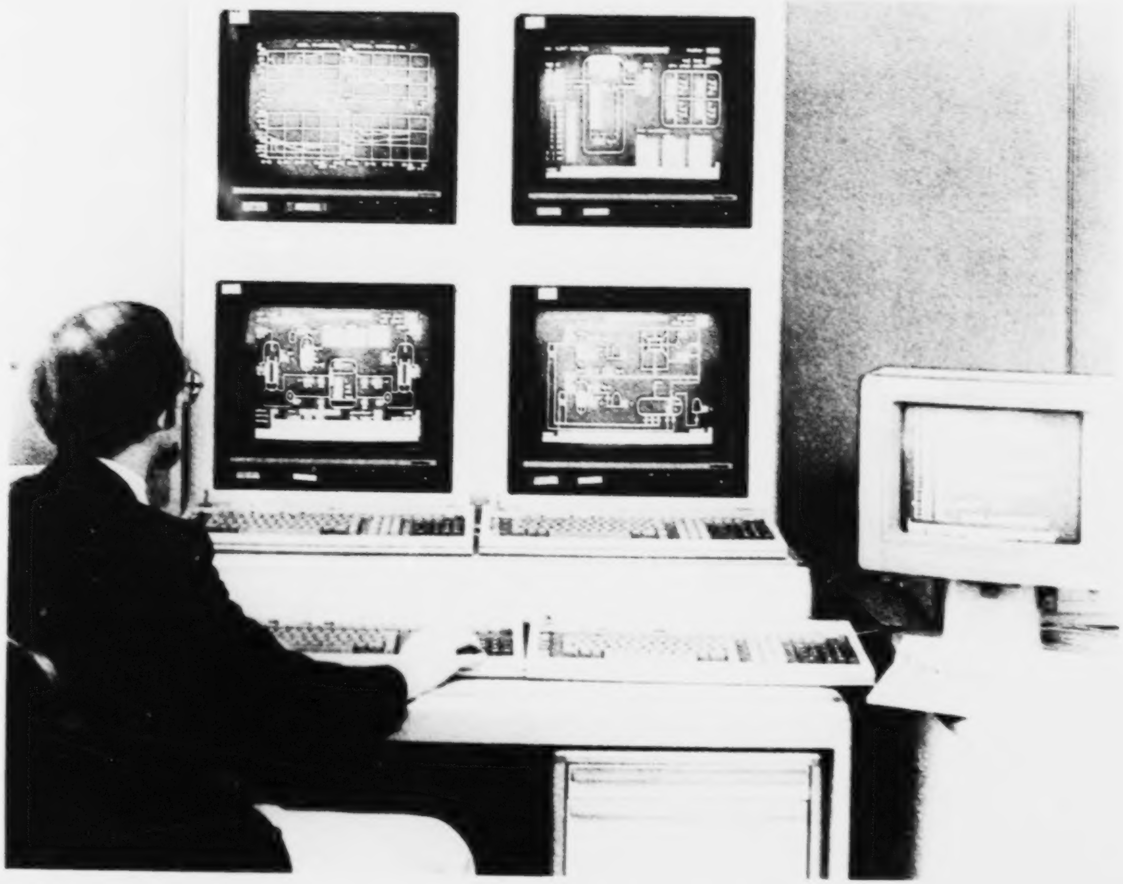

Fig. 3

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VZS6, 02/87

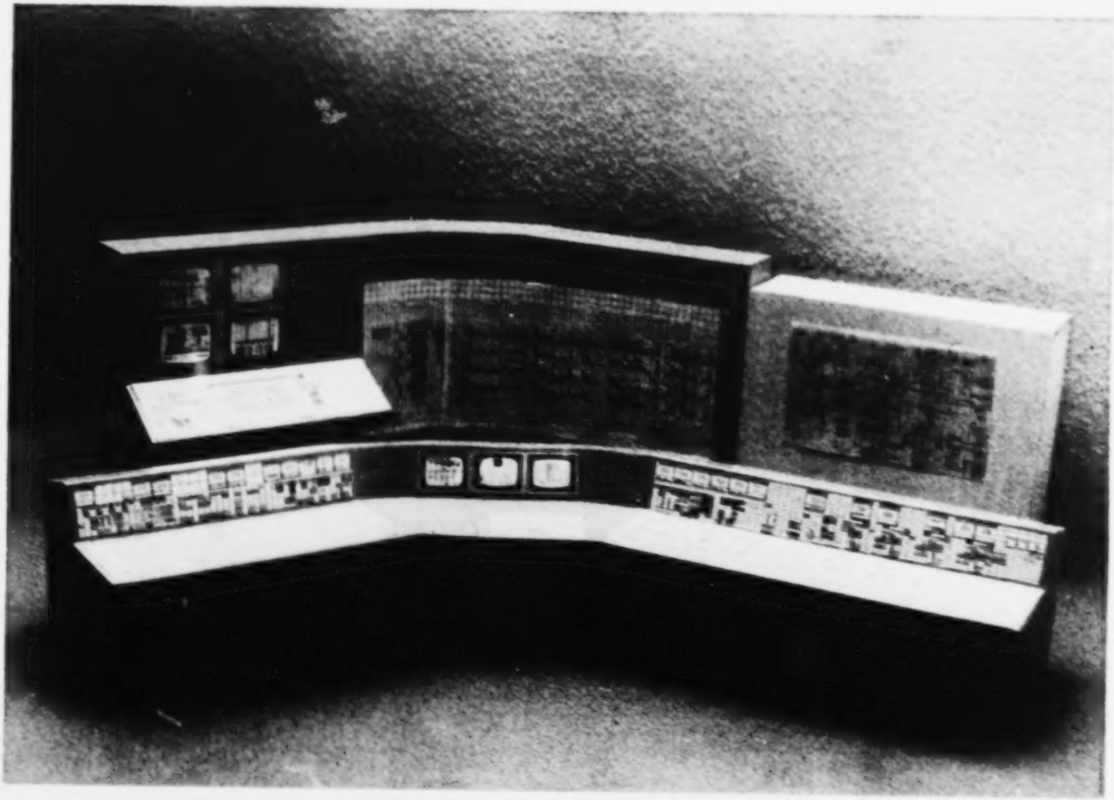

Fig. 4

VZS621034

VZS6, 02/87

COMPARING INTERACTIVE VIDEODISC TRAINING EFFECTIVENESS TO TRADITIONAL TRAINING METHODS

Nancy W. Kenworthy

ABSTRACT

Videodisc skills training programs developed by Industrial Training Corporation are being used and evaluated by major industrial facilities. In one such study, interactive videodisc training programs were compared to videotape and instructor-based training to determine the effectiveness of videodisc in terms of performance, training time and trainee attitudes. Results showed that when initial training was done using the interactive videodisc system, trainee performance was superior to the performance of trainees using videotape, and approximately equal to the performance of those trained by an instructor. When each method was used in follow-up training, interactive videodisc was definitely the most effective. Results also indicate that training time can be reduced using interactive videodisc. Attitudes of both trainees and instructors toward the interactive videodisc training were positive.

DESCRIPTION OF THE STUDY

This evaluation methodology was designed and carried out by the training staff at a major industrial facility. The purpose of the study was to evaluate the effectiveness of interactive videodisc training compared to videotape and instructor-based lessons.

In this study, journeymen mechanics with little or no formal training in electrical/electronic skills were trained in two electrical skills areas: using an oscilloscope and using a multimeter. Participants in the study were volunteers.

INITIAL TRAINING EVALUATION

Before the training, instructors at the facility developed training objectives in the two content areas. From these objectives, a written pretest, post-test, and performance tasks were developed for each content area. All trainees were given the written pretest and were evaluated on the performance tasks. The pretests were left ungraded, and locked away until the conclusion of training in order to avoid biasing the results of the study.

Trainees were randomly divided into three groups. Trainees in each group received initial training in the content area through a specific method -- interactive videodisc, videotape, or instructor-based classroom training.

The trainees in the interactive videodisc group received training from two interactive videodisc lessons developed by Industrial Training Corporation. Both lessons are Level III interactive videodisc training programs. These off-the-shelf lessons consist of a videodisc, the necessary computer software, a user's reference containing the lesson objectives, and a user's handbook which provides the information necessary to operate the hardware delivery system. Before beginning the training, each of the trainees using the videodisc system received a five-minute explanation of how to use the system. After this initial explanation, trainees were permitted to ask questions about system operation if necessary. However, the instructor was not permitted to answer questions about lesson content.

Trainees in the videotape training group used off-the-shelf videotape training programs in the content areas. These videotape programs were selected by the training staff at the facility. Trainees had the videotape and accompanying workbook. Training was done on an individual basis so that each trainee could review material as much as necessary within the time limit.

Trainees in the instructor-based training group received training through a classroom lecture format with demonstrations. Training was done in small groups. Average trainer-trainee ratio was 1:3. The instructors were experienced in the content area and had taught these subjects previously. Instructors were permitted to provide demonstrations with actual equipment, and use handouts and the chalkboard as teaching aids.

Each group was given a time limit of two hours to complete each lesson. All groups used the entire two hours.

After completing the lesson, trainees were administered the written post-test and performance tasks. The effectiveness of the training for each method was based on the improvement shown by comparing pretest and post-test scores and performance task evaluations.

PERFORMANCE -- INITIAL TRAINING

By comparing the mean pretest and mean post-test for each group, it is possible to determine how much each group improved as a result of the particular training method. Written tests were scored as a percentage of correct answers. Performance evaluation scores reflect the percentage of tasks performed according to specified criteria.After initial training, the improvement resulting from interactive videodisc training was comparable to the improvement resulting from the instructor-based training -- both on the written test and on the performance task evaluation. The improvement after videotape instruction was substantially lower. The improvement percentages were consistent for both the oscilloscope lesson and the multimeter lesson.

V.A.8.4

Initial Training

Mean Scores -- Oscilloscope

Videodisc	Written	Performance
Pretest	29%	0%
Post-test	48%	47%
Improvement	19%	47%
Videotape		
Pretest	30%	0%
Post-test	40%	27%
Improvement	10%	27%
Instructor		
Pretest	33%	0%
Post-test	50%	53%
Improvement	17%	53%

Mean Scores -- Multimeter

Videodisc	Written	Performance
Pretest	47%	7%
Post-test	66%	53%
Improvement	19%	46%
Videotape		
Pretest	40%	13%
Post-test	50%	47%
Improvement	10%	34%
Instructor		
Pretest	32%	0%
Post-test	50%	53%
Improvement	18%	53%

FOLLOW-UP TRAINING EVALUATION

After completing the initial training lesson, each group was scheduled for follow-up training using the other two methods of instruction tested in this study. The purpose of this follow-up training was twofold:

- to give each trainee an exposure to each method so that trainee attitudes toward each method could be evaluated
- to provide some indication of the effectiveness of each method as follow-up training.

At the conclusion of each lesson, trainees were again administered the written post-test and performance task evaluation so that any improvement could be noted.

PERFORMANCE -- FOLLOW-UP TRAINING

Here, some surprising results were noted. After completing the interactive videodisc lesson, trainee scores improved significantly, no matter whether they received the videodisc training first, second, or third in the rotation. Performance improvement using interactive videodisc for follow-up was superior to both instructor-based and videotape methods. These results were consistent for both the oscilloscope lesson and the multimeter lesson.

The interactive videodisc seemed especially effective in improving scores on the performance tasks after initial training. The trainees improved their performance scores an average of more than 30% following the videodisc training.

Since the follow-up training results were a corrollary to the primary study of initial training evaluation, they provide food for thought rather than conclusive results.

This is an area that ITC intends to pursue in future studies. One possible explanation for the dramatic increase in performance scores may be that ITC's videodisc skills training lessons are designed around simulations fo hands-on tasks that provide practice for the trainees.

Improvement After Initial Training

Oscilloscope	Written	Performance
Videodisc	11%	30%
Videotape	2%	4%
Instructor	9%	20%
Multimeter		
Videodisc	13%	36%
Videotape	4%	7%
Instructor	8%	27%

TRAINING TIME

Each lesson was limited to two hours in order to provide a fair basis for comparing performance. However, surveys of trainees and instructors after training indicated that interactive videodisc may provide a way to reduce training time.

Trainers in the instructor-based training complained of a lack of time to adequately cover the material. Trainees in the instructor-based groups described the speed of presentation as the primary weakness of this method of training. Trainees in the interactive videodisc training groups felt they had adequate time to complete each lesson.

V.A.8.7

TRAINEE/TRAINER ATTITUDES

After completing the lessons in each of the three training methods, trainees were surveyed to determine their attitudes toward each training method. Trainees were encouraged to comment on the strengths and weaknesses of each method, and to suggest ways that the training might be improved. Instructor comments were also solicited.

Trainee attitudes paralleled performance in terms of which methods were most effective. When asked what method of instruction they thought worked best, trainees were fairly evenly divided between interactive videodisc and instructor-based training. However, when the question was rephrased to ask which training method they would prefer if only one method were available, a clear majority chose videodisc. When asked why, trainees gave two reasons:

- The instructor often went too fast.
- The interactive videodisc protected trainees from the embarrassment of giving an incorrect answer in front of other people.

Trainers were positive about the flexibility of interactive videodisc in terms of where and when it can be used for training. They also approved of its use for independent training. The instructors compared the effectiveness of interactive videodisc to their best instructor.

Trainees using the interactive videodisc made one suggestion for increasing the effectiveness of the training that would be simple to implement. In this case, since the training on the videodisc was generic in nature, trainees thought it would be helpful to have the specific equipment that they would be using on the job available for practice after completing the simulations on the videodisc.

METHODS FOR EVALUATION OF INDUSTRY TRAINING PROGRAMS

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Julius J. Persensky

ABSTRACT

The NRC Policy Statement on Training and Qualification endorses the INPO-managed Training Accreditation Program in that it encompasses the elements of effective performance-based training. Those elements are: analysis of the job, performance-based learning objectives, training design and implementation, trainee evaluation, and program evaluation.

As part of the NRC independent evaluation of utilities' implementation of training improvement programs, the staff developed training review criteria and procedures that address all five elements of effective performance-based training. The staff uses these criteria to perform reviews of utility training programs that have already received accreditation. Although no performance-based training program can be said to be complete unless all five elements are in place, the last two, trainee and program evaluation, are perhaps the most important because they determine how well the first three elements have been implemented and ensure the dynamic nature of training.

This paper discusses the evaluation elements of the NRC training review criteria. The discussion will detail the elements of evaluation methods and techniques that the staff expects to find as integral parts of performance-based training programs at accredited utilities. Further, the review of the effectiveness of implementation of the evaluation methods is discussed. The paper also addresses some of the qualitative differences between what is minimally acceptable and what is most desirable with respect to trainee and program evaluation mechanisms and their implementation.

V.B.1.2

BACKGROUND

On March 20, 1985, the NRC issued a Final Policy Statement on Training and Qualification of Nuclear Power Plant Personnel. This guidance endorsed the INPO-Managed Training Accreditation Program because the NRC believed that the Accreditation Program encompasses the elements of effective performanced-based training. These elements are: analyses of the job, performanced-based learning objectives, training design and implementation, trainee evaluation, and program evaluation. Additionally, the NRC developed NUREG-1220, "Training Review Criteria and Procedures," to assist the NRC staff in performing independent evaluations of industry training improvement programs including post-accreditation audits. The evaluation criteria and accompanying procedures provide detailed questions for determining the extent of implementation of the five elements of effective performanced-based training. While all the elements are essential for effective training, perhaps the last two, trainee and program evaluation, are more important because they determine how well the first three are implemented and are the basis for continuing improvement of training. The focus of this paper will, therefore, be concentrated on evaluation methodology including what the NRC staff expects to find as the integral part of performanced-based training evaluation at accredited utilities, and how effectively those mechanisms are implemented. The paper also addresses some of the qualitative differences between what is minimally acceptable and what is most desirable with respect to trainee and program evaluations.

The trainee evaluation process includes an assessment of the individual prior to entry into the training program, evaluations during training, and evaluations while the individual is on the job. Aspects of this assessment include: exemptions from training based on experience, prior training or performance-based testing; regular job-related evaluations with feedback; and remediation. The focus of program evaluation is to determine the training program's effectiveness as it is implemented, and to revise it as necessary. Aspects would include aggregate evaluation of trainee test performance, trainee and instructor critiques, on-the-job evaluations by trainees, feedback from supervisors, formal program evaluation, and evaluation of training staff performance. The NRC staff performing an audit of industry training programs reviews training procedures, records, and tests and also interviews the training staff, trainees and job supervisors to determine the effectiveness of trainee and program evaluation. A more detailed discussion of evaluation methodologies is presented in the remainder of this paper.

TRAINEE EVALUATION

Exemptions

The first question included under the element of trainee evaluation is that of exemptions from any portion of training. A determination is made as to the circumstances under which exemptions from training may be granted. Minimal standards would allow exemptions without any auditable record. A more acceptable criterion for exemptions would be documented evaluation of equivalent training or performance-based testing. The most desirable method for granting exemption from training would depend exclusively on performance-based testing, i.e., testing based on the knowledges and skills needed to perform the specific job.

Test Items

Trainee evaluation should be appropriate to job performance requirements and training objectives. Test items for tasks selected are reviewed to determine that test items for all tasks are consistent with the learning objectives and job performance requirements. The most appropriate test items would require faithful indication of required actions given the stated conditions to a predetermined standard of performance, so that knowledges and skills are determined to be adequate.

Feedback

The trainees should be provided prompt, regular, objective feedback on their performance. Examples include the self-checks which can be scored by the trainee, as in self-study workbooks, or instructor-administered and scored tests. In the latter case, tests should be scored and returned within a day, but in no more than a week. In addition to feedback provided for the overall performance, feedback should also be provided relating to specific skills and knowledges that do not meet job performance requirements (i.e., learning objective standards).

Performance Below Minimum Standards

Trainees who perform below minimum standards should be provided remedial training, retested and removed from the training program if minimum standards are not met. When difficulties occur in original training, special training techniques should be used to correct them. This would require careful analysis with input from the trainee. Information regarding trainee deficiencies should also be used as feedback into the program. Job incumbents performing below minimum standards during requalification or continuing training should be removed from associated job duties and provided with remedial training. Root causes of failures in continuing training programs should also be identified and used to improve that phase of the program. During a post-accreditation audit, the staff reviews specific examples of the remediation process including additional training provided, procedures for retesting and procedures for removal from the program or job duties for failure to meet the minimum standards.

Compromise of Test Contents

Training procedures should define the steps that are taken to preclude compromise of test contents. For instance, a sufficient number of questions in the test bank facilitates variations in examinations so that questions need not be repeated between tests. A single administration of a particular examination (or several versions per administration), regular examination proctoring, and effective procedures for and implementation of measures taken against exam compromise are other measures reviewed by the staff.

PROGRAM EVALUATION

The audit team looks for evidence that the utility has a systematic method in place not only to evaluate the training program's effectiveness, but also to revise the program when necessary. There are a number of mechanisms that are good parameters for program evaluation, e.g., evaluation of test results, programmatic critiques, on-the-job feedback, formal evaluations and evaluation of training staff performance.

Evaluation of Test Results

Identification of trainees' weaknesses is relatively straightforward. Finding the cause of those weaknesses is not as simple and more training is not always the answer. One method of identifying weaknesses is evaluation of aggregate results of both written and operating tests to improve testing and to provide feedback to improve training. A good evaluation of test results usually includes a test item analysis. Test items that are consistently answered incorrectly may pinpoint the cause of program weakness and narrow the decision as to whether the fault may lie with the adequacy of procedures or other job performance aids provided, selection criteria, sequence of training or the qualifications and performance of the instructor. Evidence that such an analysis is implemented is usually found in procedures or an actual evaluation of test results from a recently completed course.

Instructor and Trainee Critiques

Both trainees and instructors are in unique positions to provide valuable input to the program evaluation process. Instructors can identify problems with technical accuracy, completeness, sequencing, and trainees' difficulties with training materials. Trainees can identify the same type of problems from the perspective of the target population. As part of a post-accreditation review, the staff determines if there is evidence that instructor critiques of training are required, are an ongoing part of the conduct of courses, and, most importantly, that there is a formal method for the timely implementation of appropriate changes to the program. The staff also reviews requirements for trainee critiques and ensures, through documentation, that they are structured, focused on desired information, and used for program evaluation.

On-the-Job Experience

A formal program for collecting on-the-job experience information from job incumbents 3 to 6 months after they complete training should be implemented and the data used for program evaluation of initial training. Continuing training can also be evaluated using similar experience information from job incumbents. The information collected should include:

(1) unexpected difficulties in performing tasks on the job,

(2) those tasks that are particularly difficult or easy to perform,

(3) any difference between the way tasks are performed on the job and the way they are taught,

(4) additional training needed to do the job, and

(5) kinds of errors committed on the job.

The staff reviews documentation to determine the existence of a formal program to collect on-the-job experience in the five areas above and to determine if the information is part of the evaluation and modification of initial and continuing training programs.

Supervisor Feedback

A formal program to periodically solicit supervisor feedback on job performance problems is an integral part of program evaluation and the information obtained should be used to improve both initial and continuing training. Information collected from supervisors should include (1) tasks for which job incumbents are inadequately prepared, (2) kinds of errors committed by job incumbents, (3) additional training received by new job incumbents once they are on the job, (4) suggestions for improvements in initial and continuing training programs, and (5) expected changes in job assignments, procedures, or equipment. The NRC reviews evidence to ensure that this feedback is proceduralized as a part of the program evaluation process and that the information is actually used to evaluate and improve initial and continuing training.

Internal and External Program Evaluation

The NRC audit determines if there have been internal or external program evaluations for the two most recent years and determines if the findings have been incorporated in the program. If the findings are not used, there should be evidence of appropriate rebuttal of the findings. External evaluations can be either from outside of the utility or merely external to the training organization, e.g., utility performed QA audit.

Training Staff Performance Evaluation

Training procedures should be in place that require a periodic (once every 12 months at a minimum) evaluation of the performance of training staff members. The NRC reviews to ensure that there is evidence that these procedures are being implemented in a consistent, accountable manner.

CONCLUSION

Without trainee and program evaluation elements, performance-based training would not have true substance or be effectively modified. For training to be truly performance-based it must be dynamic; without evaluation and feedback any training program will become static.

Information derived from the evaluation process must be used to determine program strengths and weaknesses which are then used as feedback to further enhance the training program's content and effectiveness. The review criteria of NUREG-1220 used by the NRC are designed to determine if utility training programs include consistent evaluation methodology with evidence of auditable documentation. Appropriate implementation of these two elements will ensure the dynamic nature of industry training.

ACCREDITATION SELF-EVALUATION: AN EFFECTIVE PROGRAM EVALUATION TOOL

Ronald L. Fritchley

ABSTRACT

The Institute of Nuclear Power Operation's (INPO) Accreditation Program includes a systematic evaluation that subsequently improves nuclear utility training programs. The process begins with a utility-conducted self-evaluation that measures its training programs against the accreditation criteria and objectives. When properly conducted, the self-evaluation results should identify weaknesses within each program as well as program strengths. Utilities are then expected to take the necessary actions to correct the weaknesses that have been found. Experience with the process has shown that a properly conducted self-evaluation can also be an effective program evaluation. In addition, much of the data and information that are collected and used during the self-evaluation process are also used in conducting other evaluations of the training organization and programs. This paper will discuss using the self-evaluation process as a tool for conducting program evaluations.

INTRODUCTION

At the last Symposium, INPO staff provided an update on the status of accreditation in the nuclear power industry. At that time half of the utilities had filed an acceptable self-evaluation report for at least one training program and slightly more than 30 programs had achieved accreditation. On December 16, 1986, the nuclear power industry achieved a significant goal by having 10 primary training programs at 61 specific operator plants accredited or ready for accreditation with over half of these 610 programs having achieved accreditation.

During the first few years of implementing the INPO accreditation program, all of us have learned a great deal about the process and how it can be used to improve training programs. My discussion today is based to a large extent on observations of the self-evaluation process and how it has been conducted by several nuclear utility training organizations. The following is a description of how the accreditation self-evaluation and program evaluation processes can be combined to make both of them more effective and efficient. This paper primarily addresses program evaluation as a measure of the effectiveness of the training process and the proper conduct of the training program. It does not include evaluating the results of training by assessing job performance.

SELF-EVALUATION

The self-evaluation process as it has evolved in the INPO Accreditation Program has three principal purposes-- it is intended to help the training organization and its programs improve; it provides a framework for action plans and resource requirement estimates; and it provides a firm foundation for the preparation of the accreditation self-evaluation report to be submitted to INPO. The self-evaluation is the most important part of the entire accreditation process.

The task of conducting and managing a self-evaluation requires a team effort to produce the desired results. Therefore, the process must be planned in detail and conducted in an efficient manner. In addition, it is desirable for a self-evaluation to have the following attributes:

- The process should be internally motivated. The literature on self-evaluation and organizational effectiveness suggest that an internally motivated self-evaluation is far more successful than one that is conducted with the single purpose of responding to an external agency.

- The plant and utility management is committed to the process. Management can demonstrate this commitment through goals and objectives, their advice and recommendations on key training issues and making resources available to take corrective actions.
- The design of the self-evaluation should be appropriate to the utility, plant, and training organization. This should include participation of personnel that represent the various organizational units including plant departments involved with training.
- The process should be well led. Effective group process, problem clarification and solving, and group leadership skills must be used.
- The participants should be committed to a thorough and critical self-evaluation.

The properly conducted self-evaluation is a thorough and critical comparison of a utility's training programs not only to the INPO accreditation objectives and criteria, but also to the utility's own standards as defined by policies and procedures. The utility conducted self-evaluation identifies strengths and weaknesses within each program being evaluated. Solutions and action plans are developed for the weaknesses identified and corrective actions taken.

PROGRAM EVALUATION

Program evaluation is an integral part of all training system models and is widely used as the principal method for determining the effectiveness of training. There are many ways to approach program evaluations; there is no single evaluation method, that is best for all cases.

A great deal of research has been conducted to identify the key components of a training program that can contribute to its effectiveness. These components are: organization and management, personnel/staff, training process and materials, content of the program, and utilization of resources and facilities. The accreditation objectives and criteria closely parallel these components.

The literature indicates that program evaluation is most useful when it is treated as a process--a way of decision making--and when it is applied as such. For example, while specific assessment and measurement methods can be applied to the evaluation of a given training program, the decision-making approach itself is a process that can be generalized. Decision areas must be identified, sources for data specified, methods of analysis indicated, and evaluative decisions made. These steps would make up the evaluative process for determining the effectiveness of any training program. They too, are common to the self-evaluation process.

COMBINING THE TWO

Most program evaluations focus on the implementation of an individual training program or a cluster of similar programs. Rarely does the program evaluation provide a comprehensive and in-depth evaluation of the training program, the training processes, or the training organization. The areas of organization and management are nearly always given the least amount of attention. The accreditation self-evaluation process provides an in-depth and comprehensive evaluation of the systematic approach to training as well as organization and management, training staff, and resources and facilities. When viewed pragmatically, a properly conducted self-evaluation is a comprehensive program evaluation.

The INPO Accreditation Program is implemented on a four year cycle. At a minimum a self-evaluation must be conducted for a training program every four years. The resources needed to conduct an entirely new self-evaluation every four years can be significant, and the quantity of data and information to be analyzed can be overwhelming. Since much of the information collected and used in the self-evaluation process is also used for other training related evaluations, the existing self-evaluation should be a living process. This can be done by establishing and maintaining a data and information base for each criterion. As changes are made to criteria or as data are generated the files are updated. This provides the training staff with the most current information to use for conducting self-evaluations, preparing reports, or responding to the needs of other evaluations. The self-evaluation process that has been structured to be an on-going or living process can be an effective tool to provide up-to-date data to meet the evaluation needs of the training organization. The self-evaluation has now been made a part of the management process for evaluation and planning.

THE BENEFITS

The benefits that a utility may derive by using the self-evaluation process as a program evaluation tool can be many. While organizational structure, management philosophies, and administrative policies vary from utility-to-utility the benefits to be derived will vary accordingly. However, some of the benefits that can be expected are as follows:

- The utility is provided with an on-going thorough and comprehensive evaluation of the training organization and its processes and programs.
- The redundancy of evaluations is reduced.
- A single evaluation program is more cost effective than separate evaluation efforts.
- There is less impact on the time of the plant staff--less intrusion to collect redundant data.
- The training staff can prepare evaluation reports (including self-evaluation reports) and respond to external agency information needs more efficiently and effectively.
- Training management is provided with up-to-date information for planning and decision making.

SUMMARY

The accreditation self-evaluation process is an effective evaluation tool. Properly conducted, the self-evaluation is a thorough and comprehensive program evaluation. Experience has shown that much of the data and information used to conduct a self-evaluation are used in other evaluations of the training organization and its processes and programs. The self-evaluation process that has been structured to be an on-going or living process can be an effective tool for providing up-to-date information to meet the changing evaluation needs of the training organization.

TRAINING EFFECTIVENESS FEEDBACK

Neal A. Wiggin

ABSTRACT

A formal method of getting feedback about the job performance of employees is a necessary part of all our training programs. The formal process may prove to be inadequate if it is the only process in use. There are many ways and many opportunities to get good feedback about employee performance. We need to document these methods and specific instances to supplement the more formalized process. The key is to identify them, encourage them, use them, and document the training actions that result from them. This paper describes one plant's method of getting feedback about performance of technicians in the field.

Ways To Get Feedback

Recently I heard some training feedback that I wasn't expecting: "You trained my group on how to do an inspection, and scared them so bad that most of them won't do the task at all, because they're afraid they will make a mistake!"

Wow! We thought we had a terrific program, and we do! But we created a fear of failure by not being aware of the attitude we were creating in the learning activities! We could respond with a remark about people refusing to do the tasks they are assigned. But would we get any more feedback from that source? Probably not.

No matter what methods we use to facilitate feedback about training effectiveness, they will soon cease to function unless our reponses are clear and positive. It would do no good to get defensive about our program. If somebody is providing us essential information, they need to know that we are listening and responding. If we are not getting feedback now, we must not make the mistake of thinking that the clients are satisfied; they may only be convinced that no one is going to listen anyway. Silence is our cue to get proactive, immediately.

There are many good ways to get feedback; the clue is to encourage them, enhance them and use them to make program improvements. To look for feedback only after the training program has been provided is to wait five phases too late. Begin with the needs analysis phase. What methods do you have for plant personnel to request training? Do you think of that request as an opportunity for feedback. If you have programs in effect already, the request for training may indicate a gap in the curriculum. Use the request as an opportunity to get the client to talk about training services.

Who are the trainees? If you already have training programs for these trainees, the current request may be already covered by one of them. Does the requestor know this? If so, does this request mean that the existing program needs to be revised or enlarged?

Is this request the result of some new tasks? If not, is this task on the task lists for this position? Have some priorities changed the status of this task? That is, if we are not training on this task now, is it one that we deselected or that had a low priority? If so, why is it now on the front burner?

What prompted this request? An audit? A safety report? An employee concern? A plant event? How did we become aware of this need for training? If there is some plant or industry event driving the request, the caller may be able to provide the necessary reference so that you can analyze it for scope and depth of training needed.

The Formal Method

I consider anything that tells me that we have a gap in training to be feedback about the effectiveness of the training program. Keeping that in mind, let's look at the formalized method that is expected of us, to solicit and respond to feedback about the performance of employees after they have completed a training program; it is clear that we have to have a formalized method; what we also hope to make clear is that such a method cannot be the only method, nor will it even provide the best information out of all the techniques you use.

At Seabrook Station, our training procedures call for us to follow up training with a request for feedback from job incumbents and from supervisors, anytime from three to six months after the completion of a training program. Two forms that we use appear at the end of this paper. Some of the things we have learned from this are the following:

a. Many of the employess that we trained have not used the skills since they completed training.

b. Employees often comment on training in general, whether or not they comment about the program they evaluated.

c. We get a high percentage of response from the survey. A follow-up phone call usually will bring in the remainder.

d. Supervisors return their responses promptly, but because they have often not seen the trainee perform tasks, the information is not particularly helpful. It is generally true that the classes are scheduled on bases that have little to do with when the trainee is expected to perform the work; this is partly due to the fact that we are an NTOL plant; we expect that when we are planning for outages, there will be a much greater likelihood that an employee will perform the tasks soon after training.

Feedback in the TSD Process

We started this scenario with a hypothetical request for training, and looked at how we could use that request to get training effectiveness feedback. As we proceed through the training system development procedure, we have continuing opportunities for feedback, not just about the program being developed, but about existing programs.

In the design phase, we create a scope and tentative objectives for the new program. Then we involve the client by soliciting comments on the scope and objectives, i.e., who is going to be trained, how long it will take to develop the program, how long we expect the program to run, what training setting(s) will be used etc. We can and should compare this design to other programs which we consider successful, with the intent of using what has worked well for us in the past. Now we ask the client, "What do you think?" "Will these objectives cover the tasks you want people trained to do?" "We think this is the optimum number of hours, based on experience with other courses of this type; is this feasible for you?" "How many trainees can we expect to have at a time, based on current workload?" "Do you want to continue with half-day training sessions?" "We could go gull days or non-consecutive days if you need some other arrangement?" "Which scheduling arrangement is best for you?"

Each phase of the development process should be treated the same way, that is, we should be looking for comments that will help not only with the new program, but also provide feedback about existing ones.

Documenting the Process

We have begun a Training Effectiveness Feedback File. In it we keep the initiating document and a copy of any response we have made to modify training activities as a result of it. Do you have a way to get information about employee performance over the course of the year? Do you get data from Health Physics about the number and types of errors and omissions committed by radiation workers? Is that information useful as training effectiveness feedback? Of course it is! You use it to change emphasis or to add information to your radiation worker training. You know that! You do it all the time. Do you document it? Do you have a log or memo file where you can track the changes in training that you made as a result of performance indicators? If so, put these things in it if they initiated a program or a revision to one:

1. Non-conformance reports.
2. Audit findings on the performance or work or work requests.
3. Safety reports/lost-time accidents.
4. Station Incident Reports.
5. Memos from supervisors on any aspect of training, along with

the responses.

6. Memos from you to the file, about telephone conversations concerning any aspect of training.
7. Minutes of training committee meetings.
8. Summaries of course critiques from participants.
9. Formalized feedback forms from employees and supervisors.
10. Memos from the training department to others, detailing your response to feedback. (This is an essential step in insuring that others know you really want feedback and will take action when it is warranted.)
11. Responses to Independent Safety Engineering recommendations, when these address training effectiveness.
12. Did you say thanks on your responses? If so, did you mean it?

We have to have a means of getting feedback.

We have to document that we have it.

We have to use the feedback to modify training activities; we have to document that.

We have to insure that the feedback keeps coming. To do that, we need to show that we are listening by responding non-defensively.

When we do all that, we make the employees and the supervisors partners with the training department in quality improvement.

TRAINEE'S EVALUATION OF TRAINING EFFECTIVENESS

TRAINING GROUP:

PROGRAM: ______________________________________

COURSE: ______________________________________

PHASE: ______________________________________

LESSON: ______________________________________

DATE(s): ______________________________________

1. What additional training have you received since being last assigned to your job? ________________________________

2. What unexpected difficulties or problems in job performance have you experienced? ________________________________

3. Has your supervisor given you instructions different from those received in training? YES NO (circle one). If YES, what are the differences? ________________________________

4. Have there been other differences between the training received and what is now expected of you on the job? YES NO (circle one). If YES, please explain: ________________________________

5. What changes have occurred in your job isnce you were last assigned to it? ________________________________

6. What tasks do you find easiest in performing your job? ________________________________

7. Which tasks do you find expecially challenging in your job? ________________________________

PLEASE COMPLETE REVERSE SIDE AND RETURN TO THE TRAINING DEPT.

Fig. 1. Trainee's Evaluation of Training Effectiveness.

8. Looking back, what specific training most benefited you in job performance?____________________________________

9. What kind of errors have been committed on the job?________________

10. How could training have better prepared you for your job?__________

11. What suggestions would you make to improve the training you received?____________________________________

12. What additional training do you need for your job?________________

13. Do you have other comments about training and/or its affect on your job performance?________________________________

Date:__________________________

Trainee's Name (Optional):____

Fig. 2. Trainee's Evaluation of Training Effectiveness.

V.B.3.8

SUPERVISOR'S EVALUATION OF TRAINING EFFECTIVENESS

TRAINING GROUP:

PROGRAM: ____________________

COURSE: ____________________

PHASE: ____________________

LESSON: ____________________

ATTENDEES: ____________________

DATE(s): ____________________

1. How well do trainees perform on the job, compared to experienced employees? ____________________
2. What tasks were newly trained employees best prepared to perform? ____________________
3. For which tasks were they inadequately prepared? ____________________
4. What kinds of errors have employees committed? ____________________
5. Which tasks require excessive time for trainees to complete? ____________________
6. How do recent trainees compare with those receiving earlier training? ____________________
7. What additional training have trainees received since they were assigned their present job responsibilities? ____________________
8. Have trainee errors caused equipment damage or failure? ____________________

   Has rework by maintenance personnel been required due to personnel errors or lack of adequate training? ____________________

PLEASE COMPLETE REVERSE SIDE

Fig. 4 Supervisor's Evaluation of Training Effectiveness.

9. Have employees been commended or warned for unusually good or bad job performances?____

____

10. Have you observed unexpected results from training?__________

____

11. Has training created any new problems?_______________________

____

12. What suggestions would you make to improve initial or continuing training?____

____

13. Do you anticipate any changes in job assignments or equipment which will require additional training or changes in existing training?

____

____

____

14. What current training do you consider to be excessive or unnecessary?

____

____

____

____

SUPERVISOR:______________________________ DATE:______________

DEPARTMENT:______________________________

PLEASE ATTACH A SEPARATE SHEET FOR ANY ADDITIONAL COMMENTS. RETURN TO THE TRAINING DEPARTMENT.

Fig. 5. Supervisor's Evaluation of Training Effectiveness.

FIGURE LIST

Fig. 1. Trainee's Evaluation of Training Effectiveness.

Fig. 2. Trainee's Evaluation of Training Effectiveness, page 2.

Fig. 3. Supervisor's Evaluation of Training Effectiveness.

Fig. 4. Supervisor's Evaluation of Training Effectiveness, page 2.

TRAINING EVALUATION AS AN INTEGRAL COMPONENT OF TRAINING FOR PERFORMANCE

H.J. Lapp, Jr.

ABSTRACT

A training evaluation system should address four major areas: reaction, learning, behavior, and results. The training evaluation system at GPU Nuclear Corporation addresses each of these through practical approaches such as course and program evaluation. The major aspects of each practical component of this system are described along with an organizational structure to implement. A training evaluation system is an important tool of improving plant performance by assessing trainee performance both in training and in the plant.

INTRODUCTION

Utilities can be thought of as process cultures which are characterized as low risk and slow feedback organizations. For the nuclear power industry that changed in 1979 after the TMI-2 accident. Nuclear utilities were jettisoned through that culture into high level visability on a variety of issues. As a result of the accident, the industry now has long lists of auditors or checkers. Today these external auditors attempt to provide our evaluation function for us. In some areas this may work well, but in areas like training and plant performance, it may not. Training evaluation ia a critical link in the plant performance equation, hence the idea of Training for Performance. Internal training evaluation must become an integral component of nuclear utility training. Safe, reliable, and economic plant performance are the principle goals for our industry. To be successful, our industry must become more serious about generating an internal capability at training course or program evaluation.

Traditional audits, whether done by QA, INPO, or the NRC tend to identify our mistakes. These processes reflect a belief that finding our problems is someone else's responsibility. This article presents the conceptual ideas upon which a practical evaluation system is based and the organizational arrangement needed to implement. This evaluation system helps us as an industry to prevent training caused performance mistakes before they can occur.

Finally, if performance based training is to be the overall goal for training, then the term "performance" needs to be explained further. The use of the word "performance" does not mean successful only performance of trainees in a given training program. This is certainly desirable but is not the real reason why the training is happening. "Performance" in this case means performance on the job; which leads to successful plant performance. The real purpose of training is to improve job performance - Training for Performance. An evaluation system must reflect that reality.

TRAINING EVALUATION SCHEMES

The purpose of training evaluation is to provide data to training and line management so that intelligent, prudent, and economic decisions can be made about training courses and/or programs.[1] This process is accomplished by identifying the strengths and weaknesses of the training. No one evaluation instrument can provide all the valid data that we require.

P.R. Clark, CEO of GPU Nuclear Corporation in his talk in Lyon, France at the Human Performance Workshop stated, "... in nuclear activities, it is not the admitted lack of perfection but the inability or unwillingness to learn from experience that is intolerable."[2] Since evaluation is an important tool of capturing experience, several evaluation schemes or processes exist at GPU Nuclear to identify our strengths and weaknesses. The following evaluation schemes are important tools in ensuring that we are training for performance:

- Program
- Course
- Instructor
- Trainee (while in training)
- Trainee (once back on the job)

Program Evaluation

The two most common labels used to describe training are training programs and training courses. These two labels describe training that differs primarily due to length. Training programs are usually large scale training efforts which we use to develop new personnel by certification or qualification to do specific jobs. Since each varies significantly in length, it is more practical to approach their evaluation with appropriately scaled processes. This ensures that our evaluation activities will remain manageable and economical. Some typical training programs include the Non-Licensed Operator and the Radiological Controls Technician training programs.

To better understand the complexity of a program, it may be helpful to briefly describe its anatomy. Many training programs are broken up into segments or phases such as classroom, laboratory/simulator, and OJT. The classroom may be further subdivided into fundamentals or systems. It is not unusual for these to be further broken into specific courses such as heat transfer, pump principles, rigging, or the RHR system.

Instructor involvement is another aspect about training programs which generally differs from individual courses. The conduct of our largest training program generally requires the coordination of several different instructors. This aspect can often complicate the evaluation but is an important facet that should be recognized and addressed where possible.

The continuity of a program is generally difficult to achieve when many instructors are assigned to teach. Program evaluation should be sensitive to this issue, and point out problems in this area when observed.

Since programs are generally made up of courses which are frequently grouped into segments or phases, it is important to evaluate how well the phases are tied together. Program evaluation should not only collect data about specific pieces of the training but also how well these are integrated together. I have found that in many training programs the phases are generally well designed, when viewed by themselves. However, frequent problems are found in how the phases link together or the instructors utilize the content taught in the earlier phase.

The logistics of evaluating such large blocks of training requires the evaluator to carefully determine the proper quantity and level of data to collect. If too detailed, then the evaluation process becomes unwieldly and may demand an unreasonable amount of resources to complete. Most of us are familiar with the INPO Self Evaluation Reports [3] (SER) and the resource requirements we needed to complete them. The SER is a form of program evaluation.

I have several concerns with the INPO SER process if it is used as a utility's program evaluation process as I have heard suggested.

First it's not very suitable for those programs that are not presently under the accreditation process such as General Employee Training Program. Second, implementation of the SER required an extremely large and costly resource commitment, particularly in manpower. And third, the SER process is an open process as opposed to forced choice. The criteria are shaped in open-ended terms which made it difficult for less than fully experienced evaluators to arrive at consistent conclusions. I base that conclusion on the last three years of industry experience. Many utilities had to resubmit their SER's to INPO before they were acceptable so a site visit could be scheduled. There are a variety of reasons that could be attributed to resubmissions, but I believe this format to be one of the more important reasons.

NUREG 1220, Training Review Criteria and Procedures,[4] has recently been released as the NRC's check on the INPO process. This process is also another example of a program evaluation instrument. NUREG 1220 appears to overcome my last concern about the accreditation process and SER format. NUREG 1220 evaluates each objective on a numerical scale of 1, 2, 3. These numerical criteria are defined in the context of the objective (see Figure 1).

The NRC expects that two evaluators can complete a 1220 evaluation in two to four days. If a program lasts up to a year, that means that the evaluators are seeing an extremely small part of the actual course. They would essentially be doing an evaluation of the training documents.

Figure 1: Example from NUREG 1220

Review Guidance

2.2 Are learning objectives derived from or related to the knowledge, skills, and abilities needed for successful job performance?

Scoring Guidance

For the three to six tasks selected for the review, score this question as a:

1. if learning objectives are not derived or related to the skills, knowledge, and abilities that enable the trainee to perform these tasks.

2. if learning objectives are derived from or related to the skills, knowledge, and abilities that enable the trainee to perform tasks:

   - Selected for initial training,
   - Related to emergency/abnormal operations

   (the only exceptions being any skills/knowledge that are assumed to be entry-level skills/knowledge).

3. if learning objectives are derived from or related to the skills, knowledge, and abilities that enable the trainee to perform all the tasks selected for this review (the only exception being any skills/knowledge that are assumed to be entry-level skills/knowledge).

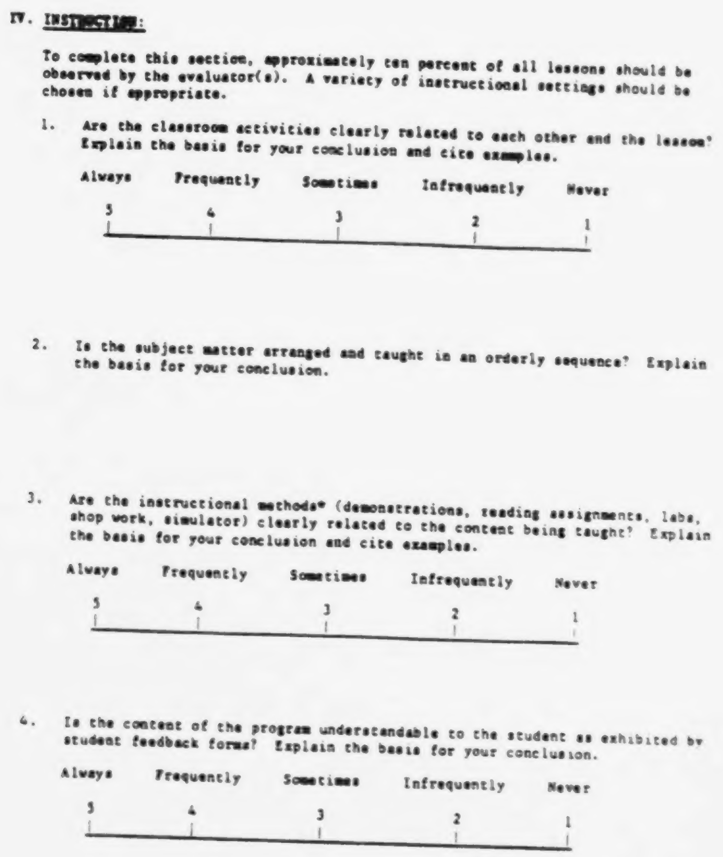
I am leary of paper drill exercises. The reality of the actual training is normally quite different from that cryptically described in the training documents. I can't overstate the fact that Training for Performance is our goal. To achieve maximum validity, evaluations should be done in the arena where performance occurs: in the classroom, in the simulator or lab, and after qualification on the job. The program evaluation instrument that is a part of our system accomplishes this since it directs the evaluator to follow the entire teaching cycle of the program. The evaluator monitors the effectiveness of the training through a reasonable number of classes through all phases. This includes going on shift to observe trainees during OJT. Additionally, it can also be done by one person!

The program evaluation instrument[5] which I have designed evaluates these long qualification oriented training programs. It examines each program in eight areas (see Figure 2). After initial experience, the instrument was revised and now includes some objectives/criteria of the accreditation process. One of the advantages of our evaluation instrument format is the use of the Likert scale (see Figure 3). Many questions are framed in a forced selection format. These are generally followed by a rating question which rates the overall quality as seen by the evaluator. An opportunity is generally provided so the evaluator can follow up with narrative comments if desired.

Figure 2: Program Evaluation Instrument Major Categories

I. Task Development
II. Objectives
III. Program Outline
IV. Instruction
V. Instructional Material
VI. Student Evaluation
VII. Training Staff
VIII. Miscellaneous

Figure 3: Typical Page from Program Evaluation Instrument



IV. INSTRUCTION:

To complete this section, approximately ten percent of all lessons should be observed by the evaluator(s). A variety of instructional settings should be chosen if appropriate.

1. Are the classroom activities clearly related to each other and the lesson? Explain the basis for your conclusion and cite examples.

Always Frequently Sometimes Infrequently Never
5 4 3 2 1

2. Is the subject matter arranged and taught in an orderly sequence? Explain the basis for your conclusion.

3. Are the instructional methods* (demonstrations, reading assignments, labs, shop work, simulator) clearly related to the content being taught? Explain the basis for your conclusion and cite examples.

Always Frequently Sometimes Infrequently Never
5 4 3 2 1

4. Is the content of the program understandable to the student as exhibited by student feedback forms? Explain the basis for your conclusion.

Always Frequently Sometimes Infrequently Never
5 4 3 2 1

BEST COPY AVAILABLE

This instrument is formatted to simplify the creation of the evaluation report. The report is written as the evaluation instrument is being completed. Experience has found this aspect a real plus in reducing administrative resources needed to conduct a major program evaluation. Additionally, it standardizes the evaluation reports format from one evaluation to another.

At GPU Nuclear, the major focus of our efforts over the last two years has been oriented towards obtaining accreditation for our last 15 major training programs. The major part of this work was in the analysis and design phases of TSD which left little time for program evaluation.[6] Since we see the value of program evaluation, we are now placing considerable emphasis on more formal evaluations.

Course Evaluation

Many of our large training programs run six months or more on average. These programs are made up of many small courses as already described. What does one do when problems emerge in only one or two courses within a long training program or in a very short program like General Employee Training?

As previously mentioned, the program evaluation instrument is big picture oriented and wasn't designed to collect detailed data. To overcome this limitation, a course evaluation process was designed.[7] Course evaluation should achieve several objectives: 1) collect detailed-specific data, 2) obtain maximum input from involved participants, and 3) collate data into a narrative summary for quick disposition.

For course evaluation, whether for existing-mature courses or for new ones just being piloted, it's important to get as many independent points of view as possible. The trainees themselves have a unique vantage perspective. But the same can be said of the instructor(s). Many excellent instructors have complained that evaluation activities typically ignores their insights. Some even feel "ganged up on" so to speak, since we work in a highly regulated industry. The course evaluation process being described here mandates that the instructors have a formal input.

The major players in course evaluation are: the trainees, the instructor(s), and a third party individual called the course evaluator. To standardize the process from application to application, a series of forms exist to keep the focus of each activity on target. The course evaluator and one or more of the instructors review the major tests after administration. It is suggested that this review be done independently. Finally, the course evaluator pulls everything together into a narrative summary report.

This summary highlights the major strengths that were observed. It also identifies the most significant areas of concern and who made the identification. This last aspect is important to add to the validity and/or comprehensiveness of the finding. The lead instructor or supervisor has an opportunity to review the narrative summary before a face to face meeting is held. This step is very conducive to generating trust and rapport. It does not, as some might think, lead to compromise. In fact, that is the process INPO utilizes in finalizing its accreditation report after its site visit. In our process, if no serious disagreements exist, then a meeting is scheduled.

This meeting should be attended by the evaluator, instructor(s), the supervisor, and senior training manager. At this time, the issues are discussed. First the strengths of the course are reviewed then the concerns. Not all sited concerns will result in follow-up actions. Much depends on the severity of the concern and how frequently it was cited. Mutual agreement is sought to strengthen the commitment to the follow-up effort.

Follow-up actions are planned for those concerns that are accepted in this review meeting. These are classified into two categories: those needing correction before the course is retaught and those that can be addressed long term. Accountabilities are assigned to individuals to accomplish these actions (the individuals who have the capability to complete these revisions are generally the ones attending this meeting). The process is problem solving focused. Both the evaluator and the lead instructor or supervisor make a joint presentation to the senior training manager. This provides them with an opportunity to show off the quality of the course by providing an objective picture of the course's current status.

To date, nearly twelve course evaluations have been completed, several evaluated newly developed courses taught for the first time. The attitude towards course evaluations by many of our instructors and supervisors is changing as a result of the methods I've described particularly getting them involved. That is something I didn't expect but am very grateful for.

In our course evaluation experience, several interesting findings have been identified. One important finding deals with theory. In our industry, it appears that in many cases, we often provide too much theory for the practical aspects being taught. In several evaluations we've completed, the trainees cited this repeatedly. And this was often independently noted by the course evaluator. It became difficult for learners to see the forest for the trees. In another area, findings pointed out insufficient opportunity to practice practical skills or tasks. Sequencing the material was taught in was another rather common finding identified. More practical suggestions were found via trainee and course evaluator comments or reactions on how to correct sequence problems. After all, our instructors are subject matter experts, and it's difficult for them to sense the impact one sequence can have over another on learning effectiveness. But trainees and course evaluators can. In retrospect, most instructors agreed to be more sensitive to course-content sequence.

Trainee Evaluation (while in training)

This is an important area in the evaluation process. Most utility training organizations expend more energy in this area than any other. Our own work at GPU Nuclear is strongly oriented towards evaluating group paced training. I hope that we will be able to shift towards diagnostic assessment as the individual enters training. That way he or she will only receive training in areas when a true need exists. This does not have to be done by expensive computer based training. It can be done economically with more traditional approaches.

Trainee Evaluation (once back on the job)

This area has been an especially fruitful area of pursuit for us. With the finalization of our TSD process, we saw this as an important evaluation activity.[8] In the past year, the Educational

Development Section (EDS) of the Training and Education Department has begun playing a more active role in this kind of evaluation.

In 1986 the Oyster Creek Operator Training Manager requested that EDS do the post training evaluations (as they are sometimes called) for one of his recently completed licensed operator training programs. The trainees had already been on shift for about six months after qualification. The primary reason for our assistance was to improve the objectivity of the collected data. The first attempt by Operator Training at getting the data was made by mailing a questionnaire to the participants and their supervisors. Returns were difficult to get, and the information collected was of little value. The former trainees and their supervisors appeared to be uncomfortable with filling out perhaps "another form." The Operator Training Manager thought in person interviews would likely be more useful. He was uncomfortable with having his instructors ask former clients, so to speak, how the program worked in a face-to-face interaction. In essence, the instructor would likely feel he was asking the trainees to now rate him personally.

EDS conducted the interviews anonymously using a series of questions in the evaluation procedure. The operators were a little nervous at first, but the Educational Development Coordinator or myself were careful to stress the purpose of the evaluation. The purpose wasn't to evaluate the former trainee since they had been so stringently evaluated during their training. To the contrary, it was their turn to help evaluate their learning experience. In addition, to minimize the threat, they were told they were not required to answer questions they were uncomfortable with. We were pleasantly surprised that no one refused to answer any of our questions. We used the interview questions from the procedure.

They willingly answered each question even one which asked them if they had made mistakes back on the job. To set the record straight, we are proud of all our training programs and our instructors. However, we learned a great deal about the program and identified about six key areas where it could be enhanced.

In one area, several ex-trainees told us they had a great deal of difficulty absorbing or retaining all the system knowledge which was taught in one continuous block. We asked them to provide suggestions. The reply we got was to integrate OJT into the systems phase. This recommendation was readily accepted by the Oyster Creek Operator Training Section.

Instructor Evaluation

One other important aspect of our evaluation efforts is instructor evaluation.[9] This evaluation area has been in place for many years now and is working quite well. Each instructor experiences several evaluations each year. Most of these are by his or her supervision to include section manager and manager of plant training. These primarily focus on technical content evaluations with secondary emphasis on the quality of the classroom instructional skills.

EDS performs one annual evaluation of each instructor. The primary focus of this evaluation is on the instructional skills. Lately the focus is shifting from what was almost a singular emphasis on teaching skills towards a balance between teaching skills and curriculum development. This latter area is exhibited through behavioral learning objectives and teaching materials such as lesson plan and trainee texts. Annually EDS evaluates all completed instructor evaluations to identify the overall strengths and weaknesses of our instructors. Two of these analyses have been with good results. The identified areas of difficulty are relatively minor. In our latest analysis, we have seen generic weaknesses in the use of audio-visual media and in application of effective questioning techniques. Two advanced instructor training modules are under development as a result of identifying these needs through evaluation.

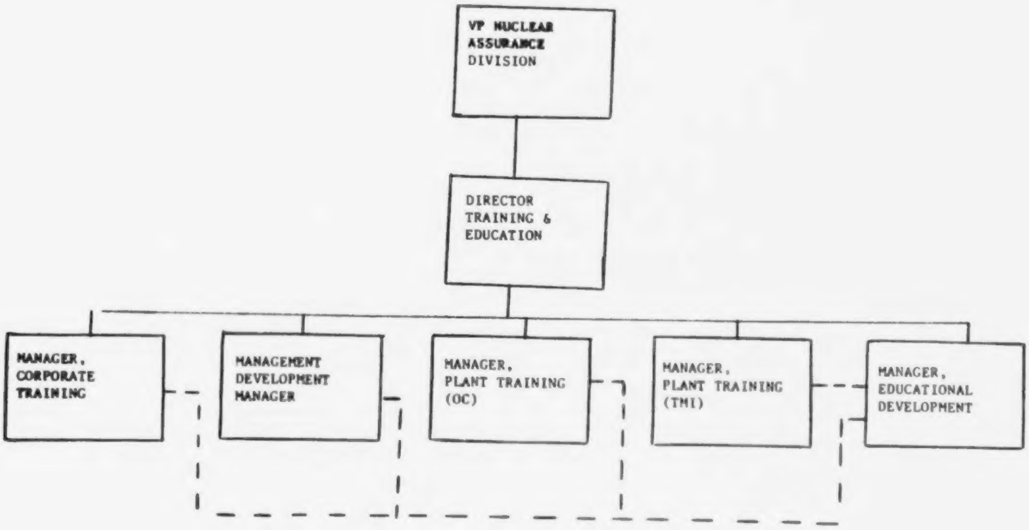
ORGANIZATION

If your plant has been through the accreditation process, you have developed and documented your systematic approach to training. It's effectiveness is highly dependent on your organization and how accountabilities are balanced. At GPU Nuclear, we have evolved to a team approach to training program development: subject matter expert, instructor, and instructional technologists.

Special attention is also being placed on knowledgeable but reasonably objective evaluations being done to support the department efforts.

To accomplish this, the Director of Training and Education Department (TED) established EDS. As our development efforts shift from TSD's front-end analysis phase to evaluation, EDS is continuing to play an active role. Figure 4 shows the TED's organization. I have added the dotted lines from EDS to the other managers to show how I perceive the emerging operational philosophy. EDS is a small, but dynamic, department resource with three (3) Educational Development Coordinators, one (1) Audio Visual Specialist (who operates our video tape studio), a Secretary, and the Manager.

Figure 4: Organization of GPU Nuclear's T&E Department


VP NUCLEAR ASSURANCE DIVISION
DIRECTOR TRAINING & EDUCATION
MANAGER, CORPORATE TRAINING
MANAGEMENT DEVELOPMENT MANAGER
MANAGER, PLANT TRAINING (OC)
MANAGER, PLANT TRAINING (TMI)
MANAGER, EDUCATIONAL DEVELOPMENT

The manager/coordinators are training-learning specialists who posses advanced degrees. Three were former educators with both secondary and some college teaching experience. In addition, three have military training experience. To balance the educational perspective with practical utility experience, one coordinator has over 30 years with the utility. He was one of the original Oyster Creek startup staff whose nuclear experience predates 1967.

Over the past two years, I have made a serious effort to further develop and enhance their training development and evaluation competencies. I achieved this by coaching sessions and OJT which closely parallels apprenticeship.

This small cadre of training specialists supports approximately 80 instructional staff located at three training sites and supports training development and evaluation efforts for corporate clients. Since our resources are quite small, we have sought ways to increase the span of our reach. A module was recently developed on course evaluation which was taught to departmental instructors. We have used instructors/supervisors as course evaluators. The educational development coordinator coaches them through the process as it is done after taking the module mentioned above.

THEORY

Evaluation has always been the soft underbelly of the educational as well as the industrial training function. There are no shortage of opinions and concepts on what it is. But training staff generally dread being assigned to do evaluations. I believe this is principally due to a lack of tangible-objective mechanisms or processes.

In the early 1960's, Kirkpatrick,[10] one of the early thinkers on industrial training evaluation, developed an evaluation model. Almost all other models available today are based on his original plan. The Kirkpatrick evaluation model has four major components: 1) reaction, 2) learning, 3) behavior, and 4) results.

Step 1: Reaction

Reaction is based on the premise that adults are knowledgeable and experienced. They generally have important things to say. Whenever possible, an evaluation system should tap into this valuable resource. In our course evaluation process, we have reaction forms for the trainees, the instructor(s), and the course evaluator (This process of soliciting reactions carries over to interviewing the former trainees and their supervisors four to six months after qualification in our model). Reaction evaluations are relatively easy to do which is likely why it is so popular. When reaction type evaluation constitutes the bulk of the evaluation system, there are tendencies to draw conclusions which are based on assumptions. To prevent arriving at questionable conclusions, evaluation must be based on other criteria as well such as learning. It isn't unheard of that training courses or programs have been cancelled or underwent drastic revision based on one negative comment from a senior management person alone. From the other extreme, there have been training courses which have received strong positive reactions which only entertained. These courses would have been dramatically changed if other data had been available. Neither of these extremes are desirable which motivates us to evaluate on other levels as well.

Step 2: Learning

Learning is not guaranteed just on the basis that a program has received a favorable reaction. Learning in this context implies retention of the facts, principles, and skills that were taught and understood by the trainees. There are five (5) guidelines that Kirkpatrick recommends be observed for measuring the amount of learning.

- Learning should be measured quantitatively.
- Where possible, pre and post tests should be used.
- Assessment must be based on behavioral learning objectives.
- Where possible, a control group should be evaluated and compared to the group that had received the training.
- Where possible, the results should be analyzed with statistical procedures for correlation and confidence verification for learning.

The principal methods which implement this guidance are generally used in the nuclear power industry: classroom demonstration and performance as well as pencil and paper tests.

Step 3: Behavior

Knowing a particular principle or possessing a skill does not guarantee that these will be used out on the job. Over the last three years, numerous articles have been written in training journals about the problem of learning transfer to the workplace environment. Perhaps that is one of the biggest challenges that remains to be solved for many nuclear utility training programs. Many millions of dollars have been spent designing the finest training programs with excellent training materials, facilities, and instructors only to find that trained or qualified people do not perform back on the job (in some cases, they are able to but prevented from performing for other environmental constraints).

Kirkpatrick's evaluation system provides five (5) guidelines that should be considered when evaluating behavior. They are:

- A systematic appraisal should be made of on-the-job performance on a before and after basis.
- The appraisal of performance should be made by one or more of the following groups (the more the better):
  - The person receiving the training
  - The person's supervisor
  - The person's subordinates
  - The person's peers or other people thoroughly familiar with his or her performance
- A statistical analysis should be made to compare performance before and after to relate changes to the training program.*

- The post-training appraisal should be made three months or more after the training so that trainees have an opportunity to put into practice what they have learned. Subsequent appraisals may add to the validity of the study.
- A control group (not receiving the training) should be used.*

The standard items are not now common to our industry. They are areas which should receive future consideration if additional improvements are going to be made.

Step 4: Results

What is the purpose of the training course or program? Is it to obtain licenses? Produce a specific number of qualified individuals for a particular job position? These have been some of the traditional measures of the results for some of our nuclear industry training programs. I can personally remember several years ago working with a very practical and hard nosed training manager. Our discussion centered on identifying the licensed operator training program results. The discussion covered considerable territory. Shortly after that, he received the pass/fail results from his plant's last set of NRC exams. A majority of his operators had failed their exams. This same scenario repeated itself with the next group of candidates. That hard nosed and practical manager was very much beside himself. He knew his job was on the line. If the training department couldn't obtain licenses, then there wasn't much purpose for it as far as senior plant management were concerned. No one knew this fact of life better than that training manager.

However, to succeed in the face of our new industry challenges, we must establish better goals and objectives for our training courses and programs than just the number of licenses we obtain. We must look for better measures that reach out into the real environment of the plant. For mechanics, the number of rework tickets and the time it takes to complete routine jobs are examples that may be considered. The Utility Nuclear Power Oversight Committee (UNPOC)[11] has just been organized. One of its prime objectives is to improve the operational performance of nuclear power facilities. One of their primary goals is stated as a question. "How can the nuclear utilities accelerate the achievement of exemplary operational performance by all U.S. nuclear electric generating units?"

Initially ten (10) areas have been identified by UNPOC as prime candidates for plant performance. Training organizations should start with these and expand them while looking for other more applicable results oriented indicators for their training evaluations. In the meantime, training organizations should aggressively evaluate in terms of reaction, learning, and behavior.

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USING EVALUATION AND FEEDBACK TO IMPROVE PERFORMANCE

Steven Ketcham

ABSTRACT

Training programs throughout the nuclear industry have undergone considerable changes in the last several years. TMI caused us to go back and take a hard look at existing training and make modifications where necessary to conform to new regulatory requirements. INPO, through the performance-based training concept, has had us again go back and look at our training to ensure that each identified performance task is addressed. Because of these and other related requirements, I believe that all of our training programs have improved. However, to ensure that these programs continue to provide relevant and meaningful training, evaluation and feedback must be an integral part of the process.

EVALUATION AND FEEDBACK

Evaluation and feedback are essential ingredients to a successful training program. They provide both a direct measurement of the effectiveness of the training program and also solicit criticism and comments from the students.

Evaluations are given to test a person's knowledge of a specific topic or his ability to perform a given task. There are several different types of performance evaluations utilized throughout our training programs: WRITTEN, ORAL, and PRACTICAL (shop, lab, simulator, on-the-job qualification). Each of these has a specific purpose and place in the evaluation process.

Written examinations provide for short- and long-term retention evaluation, but may not allow the individual to fully express his knowledge or mastery of a subject.

This is where the oral evaluation or examination takes over. It allows the individual to express, in his own words, his understanding of a topic. This gives the evaluator a better view of his overall knowledge and allows the evaluator a chance to thoroughly investigate the individual's knowledge through additional questioning. This process also provides for immediate feedback to the trainee.

Practical evaluations also have a very specific place in the evaluation process, especially where performance related tasks such as maintenance, calibration, and equipment operation are involved. Practical evaluations are given on the specific equipment and tools utilized by the trainee in the shops, laboratories, and simulators or on the job utilizing the actual plant equipment.

Written examinations are a very important part of the evaluation process. Since a majority of the training that we conduct is through classroom presentations and requires the student to obtain a specific level of knowledge of the presented material, the written examination affords us a convenient mechanism for measuring how effective our training has been. However, in order for the examination itself to be effective, it must be based on the instructional objectives derived from the job analysis and task listings.

To ensure that the written exam is providing the desired evaluative information, a multiphase process is employed. First, each test question is referenced to a specific instructional objective. Second, the exam is reviewed by another member of the training department responsible for that training. This helps to remove any bias that may have been present during the development of the exam. The examination is then approved by the Training Supervisor of that department. This approval may also take the place of the second member review. Certain exams, such as the license operator requalification exams, are also reviewed by an instructional technologist. This review looks at format to ensure that each question is instructionally accurate. In addition, each requalification exam is reviewed and approved by the station General Manager. This development, review and approval process ensures that each examination will accurately measure the appropriate knowledge and/or skills of the student.

Oral evaluations or examinations are another method of measuring the effectiveness of training. Through oral examination, the instructor is better able to determine the actual extent of the student's knowledge.

Many people have difficulty in taking written exams, especially when they are required to write out their throughts or a sequence of operations. Oral exams are a great supplement to the written exam and provide for immediate feedback to the student when a wrong response is obtained. However, like the written exam, the oral exam must also be carefully prepared and reviewed to ensure that it accurately evaluates the appropriate training material. This includes preparing the questions in advance and ensuring that each question is referenced to an instructional objective. Assigning a point value to the questions and indicating the key items expected in the answer will help in maintaining objectivity and provide for immediate feedback to the student when the correct answer is not obtained. When a response requires the use of a specific piece of equipment or other reference material, ensure that it is made available to the student or that he knows that he is responsible to obtain that material in order to answer the question. Just being able to obtain the material may be a key factor in being able to answer the question, and would be worth a majority of the point value. For this type of situation, this should be indicated on the evaluation form. As with all evaluations, the oral evaluation form should be well documented and retained on file for future reference (Figure 1).

The third type of evaluation used to measure the effectiveness of training is the performance evaluation. This is similar to the oral examination but generally involves the student demonstrating proficiency of a specified task using appropriate procedures, tools, equipment or simulators as necessary. Performance proficiency is an important aspect of training in the areas of Maintenance, Chemistry, Radiological Protection and I&C, as well as Operations. We are seeing a much greater emphasis being placed in these now, then we have in the past. This can be attributed to the fact that we have had to take a much closer look at these areas and evaluate the needs of the individual to complete the INPO requirements of the job task analysis. The need to evaulate each student in his performance of each identified performance task, has caused the proficiency level of the individuals to be raised greatly by the time he is assigned to the plant as a technician. Although he may still be required to complete some in plant qualifications, he is a more productive member of the department and requires less direct supervision.

The performance evaluation, as the oral evaluation, must be well documented to include the appropriate procedures, necessary equipment and the minimum requirements to successfully complete the performance evaluation (Figure 2).

For any of these forms of evaluation to be effective in the training process, they must be used as an evaluating tool. This means that not only will they measure the student's knowledge of a specific topic or his ability to perform a specific task, but the evaluation must be reviewed to determine if the results are in line with what is expected. In a word, if what we get is not what we wanted, then we must determine why. This is commonly referred to as feedback.

Feedback is the second ingredient to a successful training program. It comes in many forms. From an informal conversation with a technician performing an instrument calibration who states that using a specific piece of test equipment during training would have helped him in the field, to the formal End of Course Feedback Form obtained at the end of every class. No matter what type of feedback used, it is essential that it is documented, reviewed for relevance and incorporated into the training program.

Several types of feedback may be used throughout a training program at any one time. We use three various types of formal feedback in our programs.

First, there are the Immediate-End of Course Feedback Forms (Figure 3). These forms are handed out by the instructor and filled in by the students at the end of each program. For long duration programs, several feedback forms may be requested throughout the program to get a representative sample of the student's comments. These forms are divided into three major categories:

- o program content and training material
- o instructor competence and technical knowledge
- o evaluation criteria

In addition, there is room for the student's written comments. These feedback forms are reviewed and summarized by the Training Supervisor. He will generate specific action items as necessary to correct any deficiencies noted. This summary and action plan are then reviewed and approved by the Principal Training Supervisor and Department Head.

It is then placed into a tracking system where it is followed until completion of all action items (Figure 4). Upon completion, the summary and action plan are filed as an integral part of the training program (Figure 5).

Second, there is the Post Training Feedback Form (Figure 6a,b). These forms are sent out 90 to 120 days following the completion of a training program. One form is sent to the student and a second form is sent to his or her supervisor. The student's form asks him what he expected to learn from the training and whether or not the program met his expectations. The supervisor's form asks what he expected the student to learn from the training and whether or not the student's performance has improved as a result of the training. The feedback forms are returned to the Training Center where they are reviewed and summarized by the responsible Training Supervisor. The Training Supervisor will again produce an action plan to ensure that any significant comments or deficiencies are incorporated into the program for future presentations. The feedback summary and the action plan are reviewed and approved by the Principal Training Supervisor and the Department Head and they, too, are tracked until completion (Figure 4, Figure 7).

A third source of training feedback is the Performance Evaluation of Training Effectiveness or the P.E.T.E. Program (Figure 8, Figure 9). This program provides for a measured evaluation of specific tasks by supervisory and management personnel, as well as training personnel. Selected tasks from the task listing are scheduled to coincide with plant activities. This allows the evaluation to be performed on a specific task being performed by a qualified individual under actual plant conditions using the approved plant procedures. These evaluations are reviewed by both the training department, as well as plant management personnel. As with all feedback information, these are summarized and appropriate action items generated.

The P.E.T.E. Program was established in response to an INPO station evaluation item. This program has been in place since October 1985. In the beginning, this program required only an annual evaluation of each job classification group, machinist, chemist, etc. In April of 1986, this program was integrated with the Salem station's on-the-job evaluation process. This now causes, on the average, two observations a month for each job classification group. As of September 1986, twenty observations have been reported, of which three have resulted in modifications to the training process.

In essence, the station publishes a schedule of on-the-job evaluations to be conducted during a given time period. Using this schedule, training department personnel will schedule a P.E.T.E. observation. To ensure that a single task is not being observed each time, a log is maintained. Using this log, the individual will select a specific task to be observed. Upon selection of the task, the Training Supervisor will approve the selection. The instructor shall then review the appropriate lesson material to determine the "as taught" method used for training of the task. During the observation, the evaluator does not interfere with the performance of the task unless, in his opinion, there is a significant and immediate concern for the safety of personnel or equipment. In this case, he may take whatever action is necessary to prevent personnel injury or equipment damage. As with all feedback forms, the completed evaluation is forwarded to the Training Supervisor for review (Figure 10). Corrective actions are noted and forwarded along with the evaluation to be placed into the tracking system. Completed evaluations are filed for future reference.

Using a combination of each of these feedback programs, a large sampling of comments and criticism, as well as a visual indication of the training program's effectiveness is possible. Incorporation of the action plans into a tracking system ensures that necessary corrections or modifications to the program are made.

Another method of using evaluation and feedback to improve performance is through the use of Training Review Groups. Training Review Groups have been established for each specific area of training (Operations, Chemistry, Radiation Protection, Maintenance, I&C, and Engineering). These groups are comprised of the training Department Head and the Principal Training Supervisor, the plant Department Head and supervisory personnel as necessary, and a representative of the bargaining unit where applicable. These groups meet at least quarterly to discuss upcoming schedules, class loading, course feedback comments and course content. In addition, these groups review changes to the task listings to ensure accuracy. The use of the Training Review Groups has caused the plant personnel to become more involved in training so as to give them a feeling of ownership.

Alone, each of these areas would have a small impact on the overall training process. However, through a sustained, conscious effort, the evaluation and feedback programs help to ensure us that we are providing effective and relevant training to each individual.

Figure 1

ORAL EXAMINATION PRACTICAL DEMONSTRATION GRADING FORM AND INSTRUCTIONS

1. On the Form No. 301-1, fill in:
    - a. Student name
    - b. Evaluator name(s)
    - c. Course
    - d. Date of examination
    - e. After the examination, number the pages (1 of 2, 2 of 2, etc.)
    - f. Location of examination

2. The emphasis on the oral examination should be on task performance. Each task discussed or simulated shall be listed in the "TASK/QUESTION" column. The trainee shall be evaluated on his/her ability to perform (simulate) specific tasks in accordance with the applicable procedures.

3. Evaluated questions/tasks must be graded Sat. (S) or Unsat. (U) by marking an X in the appropriate block. All Unsat. (U) grades require comments.

4. If on the spot remedial training is conducted and a question is repeated, regrade it by marking a ✓ in the appropriate block.

5. On the final page, mark the appropriate box for the overall grade, sign as the evaluator and comment as necessary.

6. Conduct an examination review and have the student sign the final page. Sign as the evaluator.

7. File in accordance with procedures.

Attachment 1

Figure 1

ORAL EXAMINATION FORM

Student ______________________ Date __________

Evaluator ______________________ Page ______ of ______

Course ______________________ Location __________

Task/Question Summary	S	U	Comments
General Comments: Overall Eval.			

Evaluator Signature

ATTACHMENT I
Page 2 of 2

DATE: 10/17/84
REV.: 4

Student Review

Form No. 301-1

Figure 2

	POINTS	501-157.02-LAB 040-02 SULFURIC ACID BY TITRIMETRY
MM00-05-05000	POSSIBLE/ ACHIEVED	NOTE: USE MANUAL TITRATING BURET
SAFETY OF PERSONNEL	15 /	EYE PROTECTION (2 PTS.) RUBBER GLOVES (1 PT.) LAB COAT (2 PTS.) MSDS INFORMATION (10 PTS.)
SAFETY OF EQUIPMENT	5 /	CAREFUL HANDLING OF BURET (5 PTS.)
OPERATION OF EQUIPMENT	10 /	PROPER FILLING TECHNIQUE (5 PTS.) PROPER TITRATING TECHNIQUE (5 PTS.)
SET UP OF EXPERIMENT	10 /	STANDARDIZE NaOH TITRANT CORRECTLY (5 PTS.) PREPARATION OF KAP (5 PTS.)
FOLLOW THE PROCEDURES	15 /	PROPERLY MEASURED SAMPLE (5 PTS.) TITRATE TO PROPER END POINT (5 PTS.) DATA RECORDED CORRECTLY (5 PTS.)
MATH	0 /	INCLUDED IN CORRECT RESULTS
CORRECT RESULTS	45 /	CONCENTRATION OF UNKNOWNS - % RECOVERY: 90% - 110% CORRECT NORMALITY (10 PTS. EA.) CORRECT PERCENT (5 PTS. EA.)
FINAL GRADE	100 /	

TRAINING CENTER COURSE FEEDBACK FORM

Figure 3

COURSE TITLE ______________________ LOCATION ______________________

NAME OF INSTRUCTOR ______________________

DATE(S) OF ATTENDANCE ______________________ YOUR NAME (OPTIONAL) ______________________

DIRECTIONS:

Please circle your response on scale of 1 - 5 for each question. If you feel that you cannont respond to a particular question, leave it unanswered. If there are other areas that you wish to address, please do so on a separate sheet and attach to this Feedback Form. Thank you for your cooperation in helping us evaluate our effectiveness.

COURSE EVALUATION

	5	4	3	2	1
1. At the beginning of each lesson, the objectives were presented and explained.	Always		Sometimes		Never
2. How well were your responsibilities while at the Training Center explained?	Thoroughly		Adequately		Poorly
3. Training materials, provided to you were ______________.	Extremely Helpful		Sufficient		Inadequate
4. How often will the contents of this course aid you in doing your job more effectively?	Frequently		Often		Rarely
5. Overall, I feel that the content of the material presented in this course was ______________.	Outstanding		Satisfactory		In need of Revision
6. The pace of this course was: ______________.	Appropriate		Somewhat too Fast (Slow)		Much too Fast (Slow)

INSTRUCTOR EVALUATION

	5	4	3	2	1
1. The instructor's ability to convey their knowledge of the subject was ______________.	Outstanding		Satisfactory		Poor
2. How often was the instructor well-prepared?	Always		Often		Rarely
3. How often were the presentations clear and in a logical order?	Always		Frequently		Rarely
4. The instructor encouraged learning and was a motivator ______________.	Always		Frequently		Rarely
5. The opportunity to interact with the instructor was ______________.	Always Present		Often		Rarely
6. The instructor was able to specifically relate the training to my job ______________.	Completely		Sometimes		Rarely
7. The instructor was effective in meeting the course objectives ______________.	Completely		Somewhat		Seldom

Date: 12/19/85
Rev: 6
NTC-129

PROGRAM/COURSE EVALUATION REPORT

Figure 4

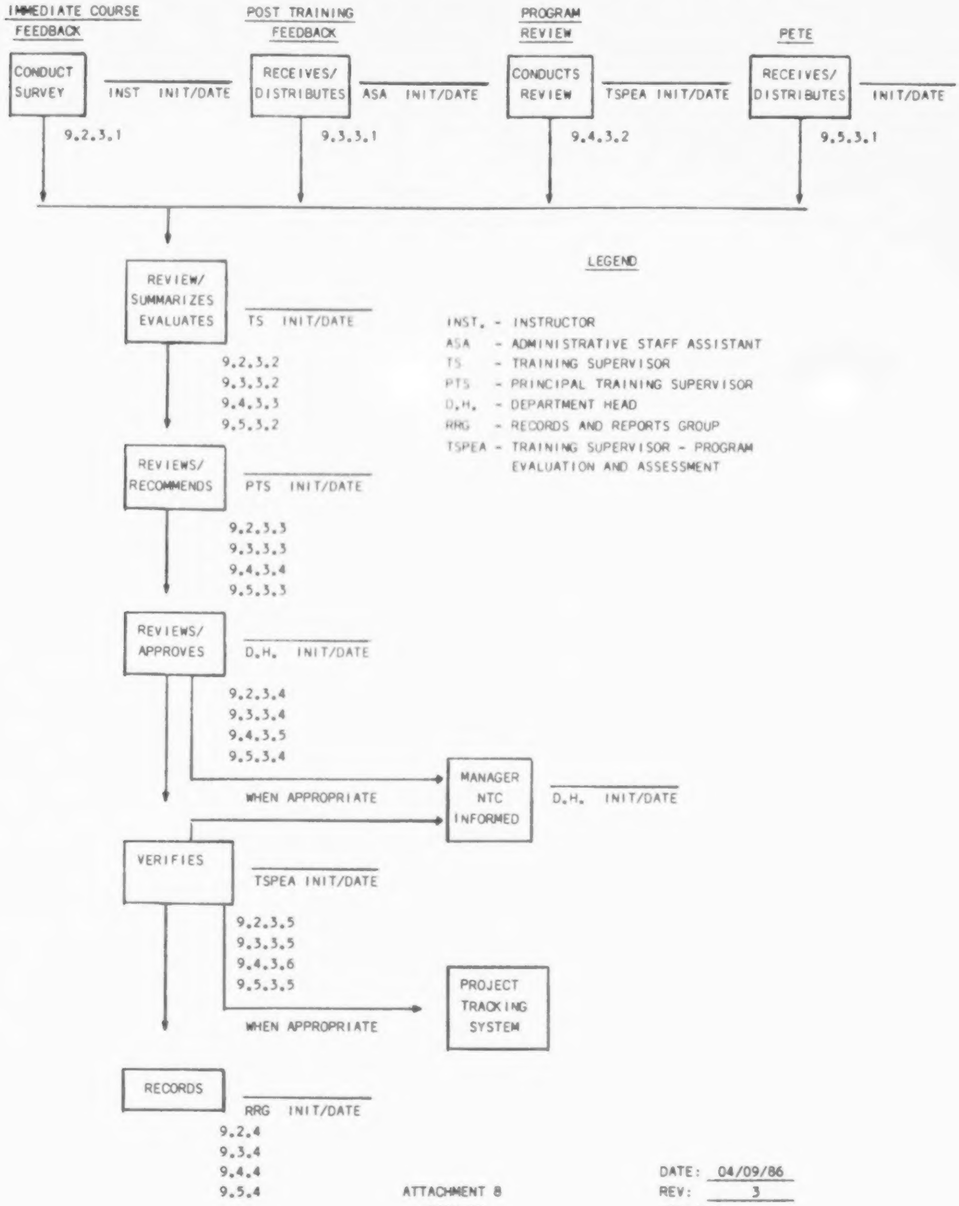
COURSE: ____________________

SEGMENT: ____________________ DATE: ____________________

EVALUATION TYPE:

- IMMEDIATE COURSE FEEDBACK ☐
- POST TRAINING FEEDBACK ☐
- PROGRAM REVIEW ☐
- PETE ☐

REFER TO CHAPTER 9 OF THE IDM FOR AN EXPLANATION OF THE ACTIONS REQUIRED (PARAGRAPHS INDICATED). ONCE THE ACTION IS COMPLETED INITIAL, DATE AND ROUTE TO THE NEXT INDICATED POSITION IN THE ROUTING PROCESS.


IMMEDIATE COURSE FEEDBACK
CONDUCT SURVEY
INST INIT/DATE
9.2.3.1
POST TRAINING FEEDBACK
RECEIVES/ DISTRIBUTES
ASA INIT/DATE
9.3.3.1
PROGRAM REVIEW
CONDUCTS REVIEW
TSPEA INIT/DATE
9.4.3.2
PETE
RECEIVES/ DISTRIBUTES
INIT/DATE
9.5.3.1
REVIEW/ SUMMARIZES EVALUATES
TS INIT/DATE
9.2.3.2
9.3.3.2
9.4.3.3
9.5.3.2
REVIEWS/ RECOMMENDS
PTS INIT/DATE
9.2.3.3
9.3.3.3
9.4.3.4
9.5.3.3
REVIEWS/ APPROVES
D.H. INIT/DATE
9.2.3.4
9.3.3.4
9.4.3.5
9.5.3.4
WHEN APPROPRIATE
MANAGER NTC INFORMED
D.H. INIT/DATE
VERIFIES
TSPEA INIT/DATE
9.2.3.5
9.3.3.5
9.4.3.6
9.5.3.5
WHEN APPROPRIATE
PROJECT TRACKING SYSTEM
RECORDS
RRG INIT/DATE
9.2.4
9.3.4
9.4.4
9.5.4

LEGEND

INST. - INSTRUCTOR
ASA - ADMINISTRATIVE STAFF ASSISTANT
TS - TRAINING SUPERVISOR
PTS - PRINCIPAL TRAINING SUPERVISOR
D.H. - DEPARTMENT HEAD
RRG - RECORDS AND REPORTS GROUP
TSPEA - TRAINING SUPERVISOR - PROGRAM EVALUATION AND ASSESSMENT

IMMEDIATE COURSE FEEDBACK PROCESS FLOW CHART Figure 5

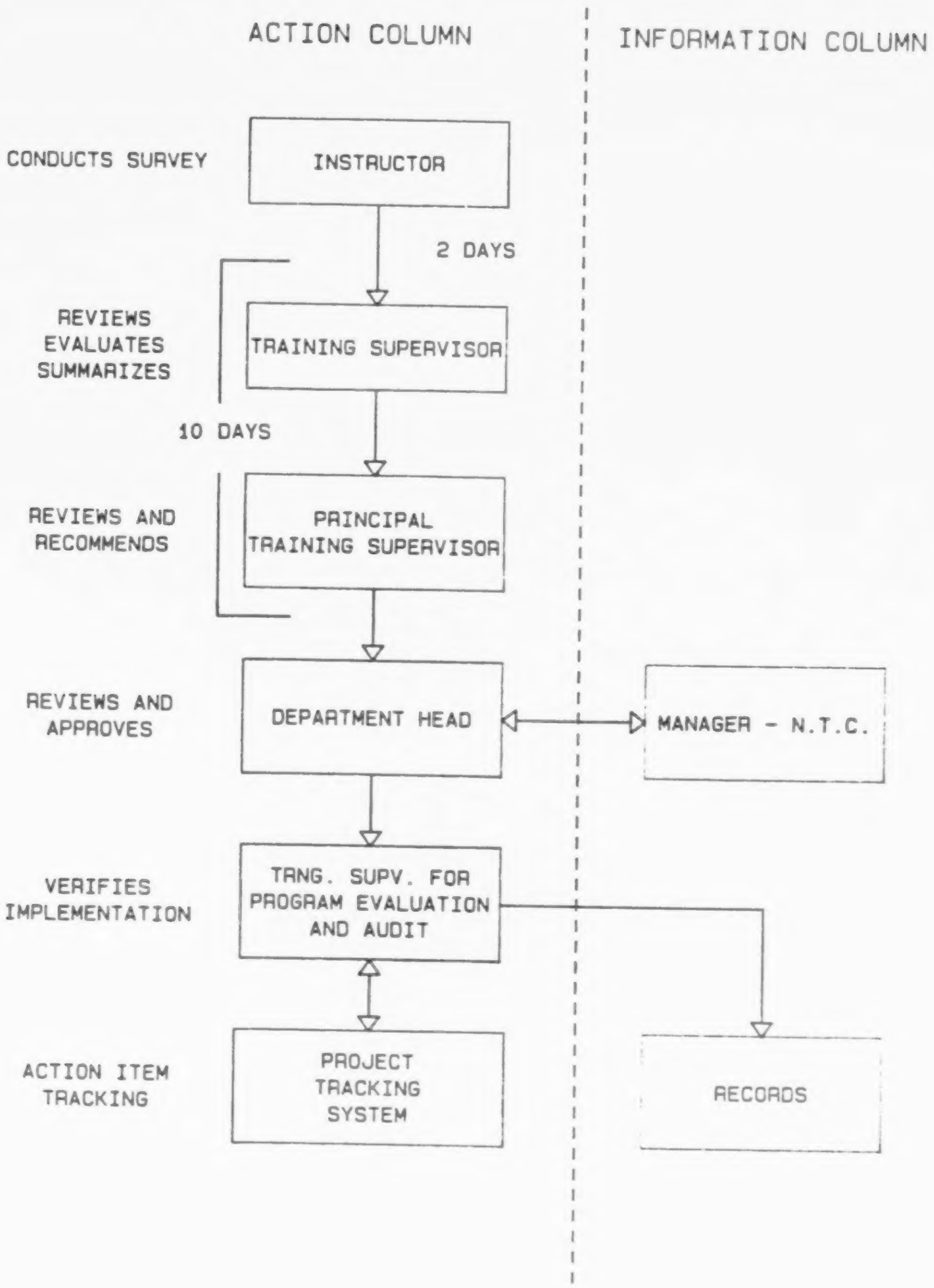

ACTION COLUMN
INFORMATION COLUMN
CONDUCTS SURVEY
INSTRUCTOR
2 DAYS
REVIEWS EVALUATES SUMMARIZES
TRAINING SUPERVISOR
10 DAYS
REVIEWS AND RECOMMENDS
PRINCIPAL TRAINING SUPERVISOR
REVIEWS AND APPROVES
DEPARTMENT HEAD
MANAGER - N.T.C.
VERIFIES IMPLEMENTATION
TRNG. SUPV. FOR PROGRAM EVALUATION AND AUDIT
ACTION ITEM TRACKING
PROJECT TRACKING SYSTEM
RECORDS

Figure 6a

CHEMISTRY SUPERVISOR
POST TRAINING FEEDBACK SURVEY

Supervisor ______________________ Date ______________

Area of Responsibility ______________________________

Trainee Name ______________________ Course Number ______________

Course Name ______________________ Course Date ______________

This form was designed to give you an opportunity to provide feedback information concerning the training your personnel received at the Nuclear Training Center. The comments that you afford may impact upon or redirect training.

1. The trainee's knowledge of the job has improved:

   1 = not at all
   2 = adequately
   3 = significantly

   Comments: ______________________________

2. The trainee's ability to perform (skills) on the job has improved:

   1 = not at all
   2 = adequately
   3 - significantly

   Comments: ______________________________

3. The trainee's awareness of safety on the job has improved:

   1 = not at all
   2 = adequately
   3 = significantly

   Comments: ______________________________

4. The trainee's confidence on the job has improved:

   1 = not at all
   2 = adequately
   3 = significantly

   Comments: ______________________________

(over)

DATE: 06/16/86
REV.: 0
NTC-171

5. The trainee's understanding and follow through on chemistry procedures has improved:

1 = not at all
2 = adequately
3 = significantly

Comments: ______________________________

____

____

6. The trainee's need for supervision has decreased:

1 = not at all
2 = adequately
3 = significantly

Comments: ______________________________

____

____

7. The trainee's ability to plan and organize has improved:

1 = not at all
2 = adequately
3 = significantly

____

____

____

8. Please identify any obvious strengths or weaknesses not covered above.

____

____

____

____

____

Please return completed form to your training coordinator or to M. Paredes, NTC, MC120.

CHEMISTRY TRAINEE
POST TRAINING FEEDBACK FORM

Figure 6b

Employee Name (optional) ______________________ Date ______________

Course Title ______________________ Course No. ______________

This form you are about to complete will give the Nuclear Training Center important feedback about its training programs. This information will be used to revise and improve this program.

Please circle the appropriate number. If your circle either 2 or 1 please comment on your specific concerns.

5	4	3	2	1
Good		Satisfactory		Poor

---

1. The training program as compared to my job responsibilities was: 5 4 3 2 1

   Specific comments: ______________________

2. As compared to typical job duties, the lab exercises were: 5 4 3 2 1

   Specific comments: ______________________

3. The ability of the course to relate to the knowledges and skills needed for my job was: 5 4 3 2 1

   Specific comments: ______________________

4. When used, the plant specific course material was: 5 4 3 2 1

   Specific comments: ______________________

(OVER PLEASE)

Return completed form to your training coordinator or to M. Paredes, NTC, MC120

DATE: 06/16/86
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5	4	3	2	1
Good		Satisfactory		Poor

5. Please circle the response most clearly representing the applicability of the CONTENT in the program you attended.

WORKER

1. Lab techniques and procedures	5	4	3	2	1
2. Plant systems	5	4	3	2	1
3. Fire and safety	5	4	3	2	1

Comments: ____________________

APPRENTICE

1. Chemistry fundamentals	5	4	3	2	1
2. Analytical	5	4	3	2	1
3. Radiation fundamentals	5	4	3	2	1
4. Radiation detection	5	4	3	2	1
5. Chemical controls	5	4	3	2	1
6. Station training	5	4	3	2	1

Comments: ____________________

TECHNICIAN

1. Chemistry fund. review	5	4	3	2	1
2. Radiation fund. review	5	4	3	2	1
3. Chem. lab instrumentation	5	4	3	2	1
4. Count room instrumentation	5	4	3	2	1
5. Chemical controls and systems review	5	4	3	2	1
6. Station training	5	4	3	2	1

Comments: ____________________

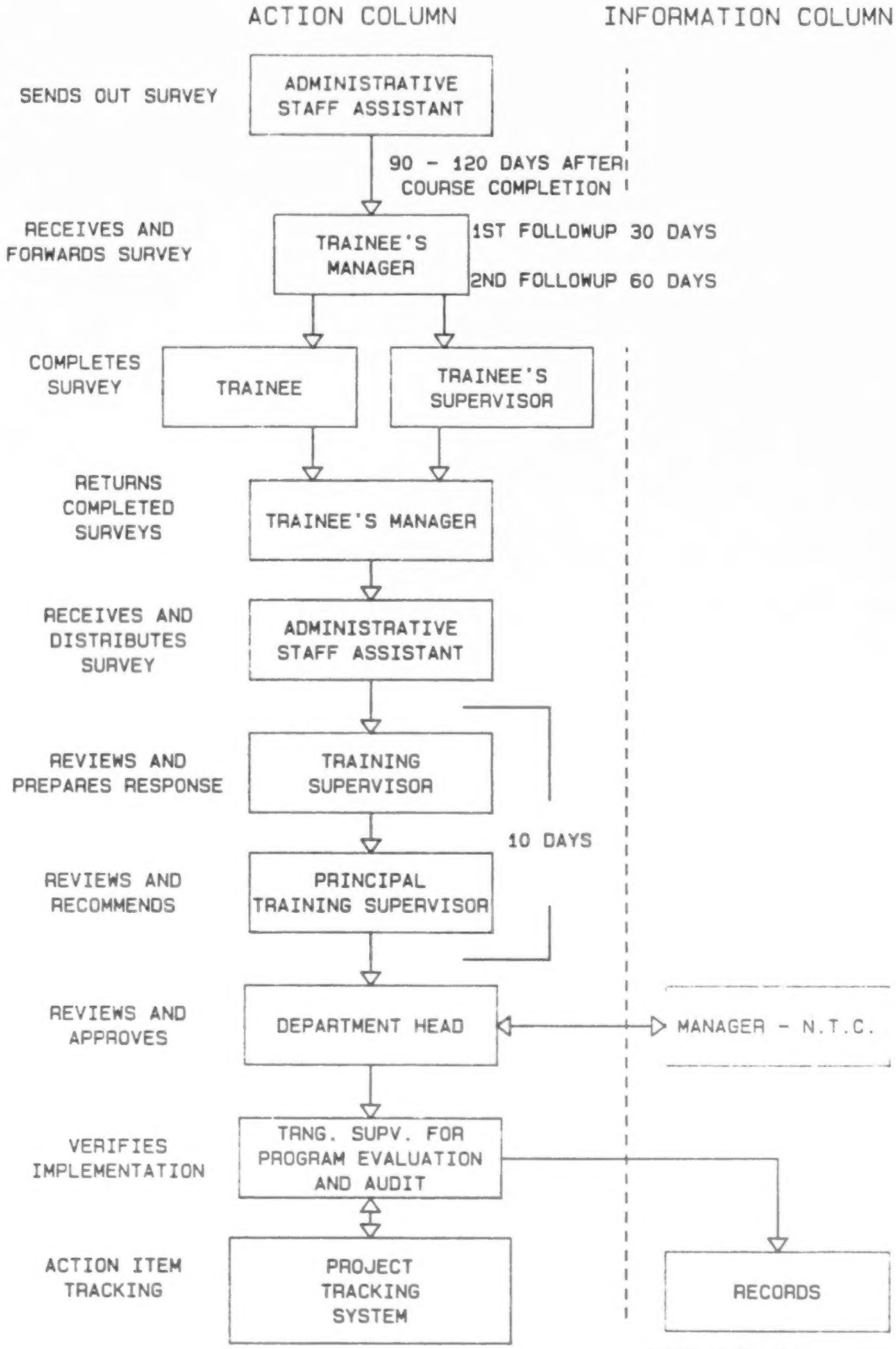
CONTINUING TRAINING

Content	5	4	3	2	1

Comments: ____________________

POST TRAINING FEEDBACK PROCESS FLOW CHART

Figure 7


ACTION COLUMN
INFORMATION COLUMN
SENDS OUT SURVEY
ADMINISTRATIVE STAFF ASSISTANT
90 - 120 DAYS AFTER COURSE COMPLETION
RECEIVES AND FORWARDS SURVEY
TRAINEE'S MANAGER
1ST FOLLOWUP 30 DAYS
2ND FOLLOWUP 60 DAYS
COMPLETES SURVEY
TRAINEE
TRAINEE'S SUPERVISOR
RETURNS COMPLETED SURVEYS
TRAINEE'S MANAGER
RECEIVES AND DISTRIBUTES SURVEY
ADMINISTRATIVE STAFF ASSISTANT
REVIEWS AND PREPARES RESPONSE
TRAINING SUPERVISOR
10 DAYS
REVIEWS AND RECOMMENDS
PRINCIPAL TRAINING SUPERVISOR
REVIEWS AND APPROVES
DEPARTMENT HEAD
MANAGER - N.T.C.
VERIFIES IMPLEMENTATION
TRNG. SUPV. FOR PROGRAM EVALUATION AND AUDIT
ACTION ITEM TRACKING
PROJECT TRACKING SYSTEM
RECORDS

NTC-174A
DATE: 10/27/86
REV.: 1

NUCLEAR TRAINING CENTER
PERFORMANCE EVALUATION OF TRAINING EFFECTIVENESS (PETE)
OBSERVATION FORM

Figure 8

STATION: S - HC JOB CLASSIFICATION(S) ____________________
DATE: ____/____/____ OBSERVER(S): ____________________
TIME(S): ____________________

WORK ORDER # ____________ / IOS # ____________ / JTA #: ____________ / DUTY AREA ____________

JOB DESCRIPTION:
____
____
____

OBSERVATION/EVALUATION ITEMS	OUTSTANDING	SATISFACTORY	UNSATISFACTORY - WHY?
1. Did personnel follow approved Procedure(s)? a. Procedure #: AP-31 (Cleanliness) b. Procedure #: ________ c. Procedure #: ________ d. Procedure #: ________ e. Procedure #: ________ f. Procedure #: ________			
COMMENTS:			
2. Did personnel use proper tagging verification procedures?			
COMMENTS:			
3. Were there delays in commencing job due to improper planning? a. List: ________			
COMMENTS:			
4. a. Were proper tools pre-staged for the job? b. Was proper tool usage observed?			
COMMENTS:			
5. Was calibration verification observed?			
COMMENTS:			

V.B.5.21

NTC-174A
DATE 10/27/86
REV: 1
Page 2

PETE Observation Form

Figure 8

OBSERVATION/EVALUATION ITEMS	OUTSTANDING	SATISFACTORY	UNSATISFACTORY - WHY?
6 Were ALARA concepts followed?			
COMMENTS:			
7 Were Safety Procedures followed?			
COMMENTS:			
8. Were communications between departments effective? SSS: _____ SS: _____ RO: _____ HP: _____ Security: _____			
COMMENTS:			
9 QA/QC involvement observed?			
COMMENTS:			
10 Did the job performance indicate the worker understanding of basic theorical knowledge?			
COMMENTS:			

Skill Observations

OBSERVATION/EVALUATION ITEMS	OUTSTANDING	SATISFACTORY	UNSATISFACTORY - WHY?
11. During performance of the job, what skills were observed? a. ____________ b. ____________ c. ____________			

NTC-174A
DATE 10/27/86
REV 1

PETE Observation Form

Page 3

Figure 8

COMMENTS:

*Significant Change Recommendations:

* Proposed Actions:

Activity	To be Completed By	Date Completed
1		
2		

Submitted By: ______________________ Approved By: ______________________

______________________ Date: __________
Prin. Training Supvr./
Training Supvr.

______________________ Date: __________
Training Department Head

Figure 9

NUCLEAR TRAINING CENTER
PERFORMANCE EVALUATION OF TRAINING EFFECTIVENESS
"PETE" PROGRAM
OPERATION OBSERVATION FORM

STATION: S - HC JOB CLASSIFICATION(S): ______________________________

DATE: ____/____/____ OBSERVER(S): ______________________________

TIME(S): ____________________

____

JTA #: ______________/ DUTY AREA: ______________

JOB DESCRIPTION:

____

____

	SAT	* UNSAT	N/A
1. UTILIZATION OF PROCEDURES			
2. COMPLIANCE WITH TAGGING RULES			
3. JOB PLANNING			
4. SAFETY PRACTICES			
5. LOG KEEPING			
6. COMMUNICATIONS			
a. Face-to-Face			
b. Remote			
7. ALARA APPLICATION(S)			
8. UNDERSTANDING AND PERFORMANCE OF TASK(S)			
9. USE OF GOOD ENGINEERING PRACTICES			
10. OVERALL PERFORMANCE			

* REQUIRES COMMENT

COMMENTS/TRAINING NEEDS ______________________________

____

____

____

DATE: 10/27/86
REV.: 0
NTC-174B

Figure 9
PAGE 2

*SIGNIFICANT CHANGE RECOMMENDATIONS:

* PROPOSED ACTIONS:

ACTIVITY ______________	TO BE COMPLETED BY	DATE COMPLETED
1		
2		

SUBMITTED BY: ______________________ APPROVED BY: ______________________________

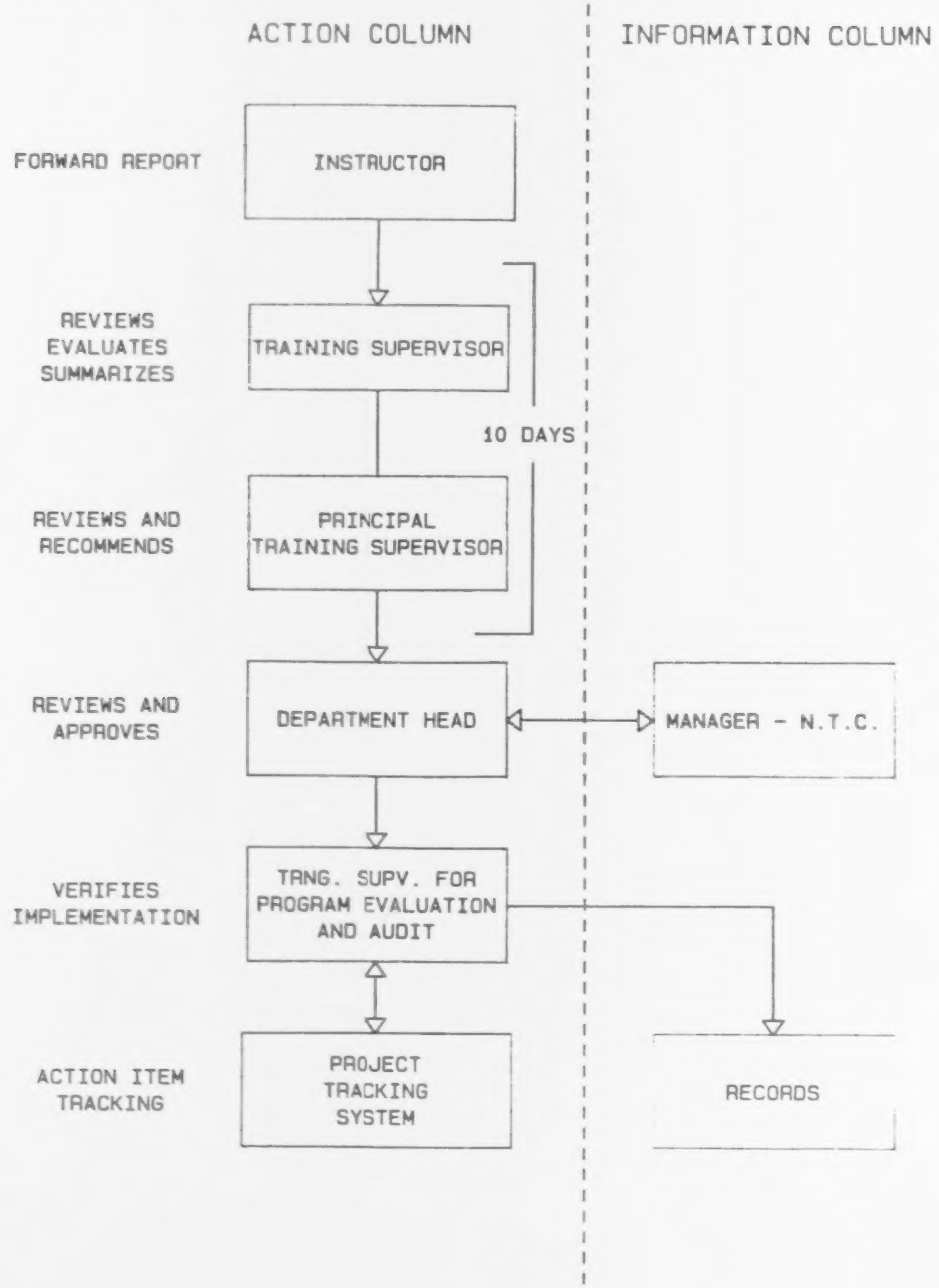
______________________ DATE: __________ ______________________ DATE: __________
PRIN. TRAINING SUPVR./ TRAINING DEPARTMENT HEAD
TRAINING SUPVR.

DATE: 10/27/86
REV.: 0
NTC-174B

Figure 10

PERFORMANCE EVALUATION OF TRAINING EFFECTIVENESS

PROCESS FLOW CHART


ACTION COLUMN
INFORMATION COLUMN
FORWARD REPORT
INSTRUCTOR
REVIEWS EVALUATES SUMMARIZES
TRAINING SUPERVISOR
10 DAYS
REVIEWS AND RECOMMENDS
PRINCIPAL TRAINING SUPERVISOR
REVIEWS AND APPROVES
DEPARTMENT HEAD
MANAGER - N.T.C.
VERIFIES IMPLEMENTATION
TRNG. SUPV. FOR PROGRAM EVALUATION AND AUDIT
ACTION ITEM TRACKING
PROJECT TRACKING SYSTEM
RECORDS

QUESTIONNAIRE
MEASURING TRAINING'S IMPACT
R.A. Corfield

FACTS:

1. Is your utility organization using any systematic, objective, quantitative method for Measuring Training's Impact?
2. If so, can you describe what you are doing?
3. Do you know of any utility using a systematic approach to Measuring Training's Impact?
4. Do you know of any published results of hard data on this subject either within our industry or in a similar or related industry?
5. Do you know if INPO is doing anything in this area?

OPINION:

1. Can we devise a systematic quantitative approach?
2. If so, what would that approach be?
3. How accurate might the results be?
4. How much effort (or expense) do you think is involved?
5. Will your utility (or the industry) financially support the development of such a systematic approach?
6. What will the money buy them (us)?
(What would be the value of the results in terms of increased, decreased, or redirected efforts or application of resources?)
7. Should we even ask the questions if we are afraid of the answers?
8. Should INPO be responsible to do this?

IDEAS:

1. What else should we be considering?
2. Would you like to be involved?

THE PAYBACK ON OUR TRAINING INVESTMENT

William A. Nichols

ABSTRACT

A tremendous amount of resources have been invested in training over the past few years. The return on the training investment will be evident over the next several years. The return will be in the form of financial savings to companies and improved performance of personnel. At the Cook Plant, we expect the return to outweigh the investment.

The D. C. Cook Plant is a large, two unit PWR that has been in operation since 1975. Following the TMI accident, we, along with the entire nuclear industry, began reassessing how training was being done and how it could be improved to more effectively prepare personnel to perform their jobs. At the Cook Plant, we faced the potential of major changes to existing training programs to make them truly performance based. The outcome of our effort is that the NLO, RO, SRO, STA, and Chemistry programs were accredited in October 1986 and the remaining 5 programs will be evaluated by INPO during an Accreditation Visit the week of May 4th, 1987.

The large investment in training made at the Cook Plant is exactly that, an investment. As with any investment that is made, the return is expected to be worth the investment. The investment that has been made is two-fold, human resources and financial resources. Since early 1984, our Training staff has grown from 20 professionals, involved primarily in Operator and GET training, to today's 57, which includes all skills programs and staffing for our simulator. Along with the growth in the Training staff, approximately 15 man-years of subject matter expertise was used to supplement our Training staff in the development and revision of all of our training programs. The financial investment being made focuses around an 85,000 ft^2 training facility that will house a full scope simulator along with laboratory, shop and classrooms to support all of our training programs. The financial investment for the training facility and simulator is approximately $30,000,000.

Measuring the payback on this large investment is difficult. Many of the areas in which training is a contributor do not have a direct financial value associated with them. Many of the areas that do have a financial value associated with them are affected by many factors, of which training is only one. On January 11th of this year, a new consecutive day run record was established for the Cook Plant. We subsequently extended that record to over 200 consecutive days. This is particularly significant since we are an ice condenser plant which requires additional planned shutdowns to perform ice condenser surveillances. The improved availability of the plant has a direct financial payback to the company. Training is a contributor to this factor, but how much of a contriburot cannot be measured.

The savings to our company by investing in our own site specific simulator will be difficult to measure. The cost per year to our company to operate our own simulator should not change much from what we spend now to contract this training. What we do expect is to be able to provide more quality time on our simulator since it will replicate our plant. We are looking at using our simulator for practicing startup and shutdown operations prior to performing these evolutions on the plant. This extra practice by the operating shifts following an extended shutdown or a record run could save time on either end of an outage. Each day's savings on an outage, because we've been able to degas or heat up more efficiently as a result of the practice, will save our company approximately $500,000. Saving one day each year for 30 years will result in a financial savings to the company of $15,000,000.

Another area in which we expect a benefit from having our own simulator is in the area of unplanned reactor trips. The Cook Plant is susceptible to reactor trips during startups resulting from manual control of steam generator levels. Controlling steam generator levels on a startup is very difficult since we do not have bypass valves around our main feed regulating valves. During the last SALP appraisal period, there were 3 reactor trips during startups when feedwater control was in manual. Recovery from this trip can take a day. We plan on using our simulator for extensive practice on controlling steam generator levels. We feel this practice will reduce the number of unplanned trips during startups. For each trip that is prevented, we expect to save $500,000 a day. Saving one day a year from these trips, over 30 years again results in a $15,000,000 savings to our company.

One of the programs that changed dramatically as a result of the accreditation process was our SRO program. Since the changes were made, our pass rate has improved from approximately 75% to 92%. The cost of putting an SRO candidate through this program is approximately $20,000. Improving the pass rate results in fewer repeats in the program at $20,000 each. We conduct the SRO program for about 12 candidates per year. Two additional passes per year applied over the next 30 years will result in a savings to our company of $1.2 million. This same logic can be applied to the RO program; however, at this time, data is not available since our first group going through our revised program will not take the license exam until August. The savings for the RO program could be much higher since it costs approximately $50,000 for each candidate. We expect the addition of our own site specific simulator to further improve our pass rates on license exams.

A performance appraisal of each nuclear utility's operation is conducted each year by the NRC. Training can have a large impact on a plant's SALP rating. In the last SALP report of the Cook Plant, training was discussed directly in 8 of the 11 categories measured.

Since training is a contributor to such a wide range of plant operations, it stands to reason that improved training can lead to improved SALP ratings. The evaluation of our plant's performance by the NRC and by INPO is extremely important to our company.

We expect returns on our training investment in many other areas and will be evaluating these over the coming year. We expect that some tasks in all programs may take less time to perform as a result of improved performance based training. This has an added benefit of reduced radiation exposures. We expect to see more consistency in the performance of tasks. Related to this will be a more efficient utilization of resources.

A lot has been invested in training over the past few years. The financial savings to a company resulting from training is just one measure of the payback. Other paybacks from training that are not easily measured but are extremely important include increased confidence in job performance, shaping of attitudes, and improved efficiency of operations. At the Cook Plant we feel the payoff from training will more than justify the investment.

INITIATIVES IN TRAINING PROGRAM EVALUATION OUTSIDE THE NUCLEAR UTILITY INDUSTRY

C. James Allen

ABSTRACT

Training literature is reviewed, and program evaluative practices outside the nuclear utility industry are reported. The findings indicate some innovations in philosophy and practice of program evaluation, although not necessarily in the context of evaluation as a route to assessing the impact of training. Program evaluation is described in the context of the impact of training, suggesting continued efforts to accept a multivariate concept of individual and organizational performance.

INTRODUCTION

The philosophies and practices that define instructional systems in the nuclear utility industry has roots in the experiences of other industries and businesses, in the annals of educational researchers, and in the theories and concepts of the disciplines of Education and Psychology, among others. As the nuclear utility industry evolves its methodologies and philosophies via symposia, industry groups, regulatory mandates, and procedural refinement, it is invaluable to return to those roots, to "expand the gene pool" of knowledge, practice, and sound educational principle. As the past six to eight years have witnessed an explosion in instructional sophistication in the industry, other industries and businesses have compiled many lessons learned. As economic tides dictate business necessities, training managers in countless types of organizations strive to justify and demonstrate training's contribution to the bottom line.

Central to the notion of measuring training's impact is the more fundamental concept of training program evaluation. While addressing impact implies assessing training's value to the organization, i.e. to the bottom line, training program evaluation encompasses assessment of training's value to individual trainees, departments, and other components of the organization. Assumptions are made about relationships of those parts to the whole. Indeed, program evaluation remains somewhat a necessary but not sufficient mechanism in efforts to measure training's impact.

THE LITERATURE

Sara Steele described trends in program evaluation in 1973[1]. Her observations seem yet to be realities in many evaluative endeavors:

1) Program evaluation is a process rather than a product; it is more than a specific methodology (estimates are that more than 50 evaluation methodologies evolved in the late 60's and early 70's). Yet, in order to maximize the utility of evaluation, it must serve as a means of forming judgments about programs and a means of collecting information to use in comparing alternatives.
2) Program evaluation is more than examining attainment of objectives. Objectives undoubtedly provide a focus for our attention, but training also produces unexpected side effects, good and bad. Sadler[2] describes "goal-free" evaluation, in which objectives of a program are set aside while evaluation occurs; prespecified objectives might not be met at all, while other results appear that are too positive to ignore. Steele goes on to state that examining attainment of objectives is primarily a descriptive activity, while evaluation, insofar as value is its central tenet, addresses whether the results of training are important, whether training contributed more than other events that could have occurred, and whether results contributed to overall needs of the organization.
3) Program evaluation is more than evaluating program results. Summative (end-of-program) evaluations are well established in most training organizations. Formative evaluations, performed while training is in process or even development, provides more immediate feedback and influences the current program as well as future ones. Komras[3] suggests conducting the first evaluation after completing the first draft of training materials. The emphasis on evaluation, according to Steele, is shifting from solely the summative to the relatedness of summative and formative.

4) Program evaluation is more than instructional evaluation. Instructional evaluation is concerned primarily with specific course or program activities. Program evaluation is concerned with the cumulative effects of a series of instructional events. Program evaluation focuses more on overall organizational needs than on specific objectives or individual states of learning.

So the contemporary trends in program evaluation expand its role beyond assessment of training for the sake of the training system alone. Evaluative methodologies cannot be far behind. Kelley, Orgel, and Baer[4] state, "The development of evaluation methods that identify a training program's benefits and costs accurately and thoroughly may become the most important contribution of training and human resource development in the 1980's" (p. 32). They advocate the statistical analysis of pre- and post-training performance measurements taken with trained and untrained (control) employees. Further, they recommend using graphic comparisons of performance data to illustrate how great the differences in performance actually are. Indeed, statistical analyses identify the results of training beyond what chance might produce. Finally, they espouse the collection of on-the-job performance data in lieu of only trainee and/or supervisory questionnaire data. This advice, although well-based in sound theory, is fraught with difficulties of implementation. Most notably, the use of untrained control groups for statistical comparison continues to be a logistical and ethical near-impossibility.

Quinn and Karp[5] also recommend the use of pre- and post-training assessment, but utilizing questionnaires that are validated (by, for example, correlation of alternate form questionnaire responses).

The training, educational, and psychological literature does not abound with true innovations in methodologies or practice in the program evaluation. Philosophies are evolving and will ultimately find expression in varying degrees.

VI.3.4

IN OTHER INDUSTRIES

Lessons are being learned in industries other than nuclear utilities. Salinger[6] surveyed evaluative practices in the Federal government and described several innovations. A program of the Department of Agriculture teaches evaluators both the techniques and orientation of evaluation. The Department of Education turned trainers into evaluators, assessing via interview the success of trainees' application of learned skills some time after training. The U.S. General Accounting Office employed both formative (assessing trainee reactions and knowledge gained) and summative (assessing application of learned skills on the job) evaluations - process and product evaluations, respectively. The Department of Labor compared productivity goals and actual achievements as a means of assessing course effectiveness.

In a light manufacturing industry in Texas, evaluation of training of QC inspectors was conducted following an eight-week course. The evaluation deemed the program successful. The course was reduced to three weeks in duration; no evaluation was conducted again. The commitment to evaluation must be ongoing to assure that changes in the programs, the participants, the instructors, and/or the organization do not render initially positive evaluation results invalid.

Likewise, an industrial construction firm evaluated training via informal field testing, then abandoned evaluation efforts after few attempts. Neither employees nor trainers welcomed the evaluation, suggesting the need to de-personalize such activities and to stress the positive aspects of evaluation.

A major oil/gas refining industry evaluated the success of a modular program for technical/production personnel. The program was designed on the basis of a needs assessment involving 1,100 employees' responses to need-for-training on 88-89 "competencies." A statistical cluster analysis identified the content of modules. The first few modules were implemented in a pilot program with experienced supervisors and managers. Pre- and post-training questionnaires assessed which behaviors were affected by training. Performance improvements were indicated.

There are numbers of fossil utilities adopting performance-based qualification procedures which double as assessments of training effectiveness.

Training program evaluation is certainly but one aspect of assessing the impact of training. Both the literature and industry experience outside nuclear utilities support generalizations about common problems to be solved in assessing the impact of training. Human behavior is affected by many factors; job performance, only one category of behavior, can be explained partially by factors attributable to training, but only partially. Second, organizational performance - and the bottom line - is also affected by many variables, of which human performance is but one.

The attempts to assess the impact of training will improve as success is achieved in identifying and controlling the intervening variables in both human behavior and organizational performance.

REFERENCES

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3. H. Komras, Training and Development Journal 39, 9 (Sept., 1985).
4. A. J. Kelley, R. F. Orgel, and D. M. Baer, Training and Development Journal (August, 1984).
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6. R. D. Salinger, Training and Development Journal 39, 8 (August, 1985).

The following paper was not received in time to be published in the proceedings. Space is provided below for notes.

Training: Is It Really the Solution?....................................
Joseph A. Gonyeau, Northern States Power Company

NOTES:

EVALUATING PERFORMANCE MEASURES TO DETERMINE TRAINING EFFECTIVENESS

Dr. Robert W. Klemm

Anthony S. Feiza

ABSTRACT

This research was conceived and dedicated to helping the CECo training organization become a more integrated part of the corporate business. The target population for this study was nuclear and fossil generating station employees who directly impacted the production of electricity. The target sample (n=150) included: instrument, mechanical, and electrical maintenance personnel; control room operators; engineers, radiation chemists, and other technical specialists; and equipment operators and atterndants. A total of four instruments were utilized by this study. Three instruments were administered to the generating station personnel. These included a demographic form, a learning style profile, and a motivational style profile. The focal instrument, a performance skills rating form, was administered to supervisory personnel. Data analysis consisted of three major parts. Part one established internal consistency through Cronbach alpha statistics. Part two provides summary statistics and breakdown tables for important variables. Part three provides inferential statistics responding to the research questions. All six Performance Skills variables discriminated significantly between the "trained" and "non-trained" groups (p .001). In all cases, the mean value for the "trained" group exceeded the mean value for the "non-trained" group. Implications for further research indicate that training does have a quantifiable effect on job performance.

BACKGROUND

The relationship between training and performance has long been an issue that has defied objective research [1]. Commonwealth Edison (CECo), as well as other utilities, have a need to know "how" to relate training benefits with the overall corporate mission: generating megawatts efficiently and safely.

An article in the February 1987 issue of the "Training and Development Journal" best expressed the changing role of trainers. This article states, "... that instead of training and developing others in the time-honored way, many more of you will be involved in managing training better, accounting for it better, and finding ways to do it better. You will, in short, be doing work that supports and advances a critical business function [2]."

This research was conceived and dedicated to helping the CECo training organization become a more integrated part of the corporate business. It was hoped that the process of doing this research would heighten the awareness of management and trainers to the fact that the training function does, and will continue to, improve employee performance, and contribute in a significant way to overall corporate objectives.

METHODOLOGY

The target population for this study was nuclear and fossil generating station employees who directly impacted the production of electricity. The target sample (n=150) included: instrument, mechanical, and electrical maintenance personnel; control room operators; engineers, radiation chemists, and other technical specialists; and equipment operators and attendants. Training records from each participating station were used to identify employees who received more task-specific training than their counterparts. The quantity of training received was the criterion used to form the "trained" and "non-trained" research groups, specifically, less than 50% of required courses completed versus persons completing 80-100% of courses. This method excluded the "annual-type" training courses.

Data collection was conducted at each participating generating station. Two methods were used to select participants. First, convenience sampling which included all available personnel. These subjects were asked by their supervisors to complete the survey instruments. Subjects were randomly selected from the convenience sample, and then assigned to either trained or non-trained research groups based on training records. Second, specific sampling, which included participants identified by the researchers through training records. These subjects were randomly selected from training records prior to data collection.

All participants were asked to complete a series of three questionnaires. The immediate supervisor of each participant was asked to rate their subordinate using the performance skills instrument. Instruments relating to each participant, those completed by the employee and his respective supervisor, were stapled together to form a packet. Each packet was coded either "trained group," or "non-trained group." All names and identifying markings were removed from these packets to maintain anonymity.

Throughout this project, only the researchers knew the group status of each participant. Selection biases [3], Hawthorne and "halo effects" [4], and other threats to internal validity [5] were minimized by the randomized, single-blind, selection process [6].

INSTRUMENTATION

A total of four instruments were utilized by this study. Three instruments were administered to the generating station personnel. These instruments will be highlighted more specifically in a follow-up study of employee learning profiles. These included a demographic form, a learning style profile, and a motivational style profile. The focal instrument, a performance skills rating form, was administered to supervisory personnel. This instrument was designed to elicit supervisory performance ratings for each participant.

The demographic questionnaire included age categories, gender, current and past job classifications, and years spent in current and past job classifications.

The learning style profile [7] was designed as a self-analysis tool for identifying four basic styles through which the mind receives and processes cognitive information. These styles are Concrete Random (CR), Concrete Sequential (CS), Abstract Random (AR), and Abstract Sequential (AS). Each style is characterized by learning, environmental, and interactional preferences for the learner (see Table 1 below). Learning style preferences among generating station personnel may provide valuable insights for training departments. Internal consistency coefficients [8] ranged from 0.89 to 0.92 for each learning style. Test-retest coefficients ranged from 0.85 to 0.88 for each learning style. Construct validity coefficients ranged from 0.55 to 0.76.

Table 1: Learning Style Themes

Style	Environment	Relationship to Instructor	Relationship to Students
(CS)	low tolerance for distraction	traditional subordinate	ordered
(AR)	high tolerance	"guide" role	collegial
(AS)	low tolerance for distraction	expert	minimal
(CR)	stimulus-rich	instruction guide	varied

The motivating traits instrument [9] was designed to identify motivational preferences. Each item represents a different motivating need-state [10]. Internal consistency coefficients for each of three motivational clusters ranged from 0.71 to 0.79. Cluster one represented self-esteem needs coupled with affiliative and self-protective needs. Cluster two represented job security and orderliness needs. Cluster three represented ambition and creativity needs coupled with respect for authority and regulations.

The performance skills questionnaire was designed to elicit performance ratings of plant personnel from their immediate supervisors. Six performance skills themes were identified by subject-matter experts from the generating stations, Program Development, and literature review [11]. These performance themes are: 1), concentration and awareness of hazards; 2), handling stress and pressure in job tasks; 3), experience and background skills; 4), resourcefulness and problem-solving approaches to job-related tasks; 5), responsibility for equipment and procedures; and 6), manual dexterity. Five items were written for each performance theme. The items were written to provide a difficulty range for each performance theme. For example, item #1 was the simplest skill for the category; item #5 was the most difficult skill for the category. A one (low) to ten (high) Likert scale was chosen to rate each item. The one-to-ten scale conforms to traditional, "base ten" rating norms, and counteracts any response biases from the customary one-to-five scale used by the Company.

Internal consistency coefficients ranged from 0.93 to 0.97 for each performance theme (see Table 2). These high reliability estimates also support content validity issues. That is, the items appear to be interpreted alike by both subject-matter experts designing the instrument, and station supervisors utilizing the instrument. The internal consistency coefficient for the total instrument was 0.74. This indicates that separate subscores representing each of the six performance themes is more appropriate than an overall, total score.

Table 2: Performance Skills Reliability Coefficients

THEME	COEFFICIENT ALPHA
Concentration/Hazards	0.9353
Stress/Pressure	0.9455
Experience/Background	0.9654
Resourcefulness/Problem-solving	0.9442
Responsibility for Equipment, etc.	0.9587
Manual Dexterity	0.9688

DATA ANALYSIS

Part One

Data analysis consisted of three major parts. Part one established internal consistency through Cronbach alpha statistics [12]. Factor analysis of the Performance Skills and Motivational Traits instruments were used to establish fewer, manageable, item clusters. These item clusters were interpreted and named according to the underlying thematic content. Principal components extraction with varimax rotation was used for these analyses [13]. Factors with eigenvalues greater than 1.00 were retained. Part two provides summary statistics and breakdown tables for important variables. Part three provides inferential statistics responding to the research questions. Discriminant analysis [14] determined differences in predictor variables between employees classified by the criterion variable.

Part Two

Factor analysis [15] was performed on the Performance Skills instrument. The results indicated a one-factor instrument: Factor 1 (eigenvalue = 22.16), Factor 2 (eigenvalue = 1.34). The one-factor solution was discarded for two reasons. First, factor analysis was more sensitive to global rating from supervisors. Supervisors were suspected of applying a global image of each participant toward the instrument. The one-factor solution represents the one-factor rating system applied by the respondents. Second, the reliability analysis demonstrated that all six performance skills themes were appropriate to use as separate measures.

The Motivational Profile was subjected to data reduction using principal-components factor analysis with varimax rotation. A three-factor solution was retained for interpretation. Factor one (eigenvalue = 4.63) represented self-esteem needs coupled with affiliative and self-protective needs. Factor two (eigenvalue = 2.58) represented job security and orderliness needs. Factor three (eigenvalue = 1.96) represented ambition and creativity needs coupled with respect for authority and regulations.

Table 3: Motivational Themes Reliability Coefficients

THEME	COEFFICIENT ALPHA
Factor One	0.7420
Factor Two	0.7063
Factor Three	0.6176

Part Three

A variety of descriptive statistics were calculated for the overall sample, "trained" group, and "non-trained" group. Important variables and statistics will be highlighted.

Of the 150 participants, 76 represented the "trained" group, and 74 represented the "non-trained" group. Males comprised 98% of the participants. Job Classifications were summarized as follows: maintenance (52%), operators (8%), ED/EA (11%), health physicist (2%), all others (17%), and missing (10%). The average value for Years in Current Job was 5.1 years. The predominant learning style was Concrete Sequential (74%).

The following statistics were computed for the "trained" status group.

The average age range was 30-39 years old (50%). The average value for Years in Current Job was 4.6 years. The average score on the Performance Skills form was 165 out of 300 possible points.

A stepwise discriminant analysis program [16] was computed to detect differences between the "trained" and "non-trained" groups from among the six Performance Skills variables. The Performance Skills variables must meet or exceed a significance level of 0.05 (= 0.05) to qualify as discriminating variables. A test for the appropriateness of multivariate normality was demonstrated by Box's M statistic [17]. The value for M was 2.3120; not significant, indicating that the discriminant analysis was appropriate given these data.

All six Performance Skills variables discriminated significantly between the "trained" and "non-trained" groups (p .001). In all cases, the mean value for the "trained" group exceeded the mean value for the "non-trained" group. A classification program was performed to predict one's group membership (trained vs. non-trained) given the raw scores from all six Performance Skills themes. Training group status was correctly predicted in 78% of the cases. Non-training group status was correctly predicted in 72% of the cases. (50% correct predictions would be expected by random guessing, or chance).

Specific results for each Performance Skill Theme are shown in the following table. The results are expressed in percentages.

Table 4: Performance Skills Percentages and Summary

Performance Skills	Non-Trained	Trained	Percentage Increase
1. Aware/Hazards	56.6	72.8	16.2%
2. Stress/Pressures	53.8	67.2	13.4%
3. Experience	57.0	72.6	15.6%
4. Problem-solving	53.6	67.6	14.0%
5. Responsibility	55.0	69.4	14.4%
6. Manual Dexterity	54.4	70.4	16.0%
Overall	55.1	70.0	14.9%
Median Age Level	35.0	35.0	
Years in Current Job	4.6	5.7	

SUMMARY

Implications for further research indicate that training does have a quantifiable effect on job performance. The following questions -- "Were the results what one would expect?"; "Is there enough improvement?"; and, "How much are we saving, or are we spending too much?" -- can only be answered in the context of this study.

Expectations were optimistic, that is, we expected positive results from our training. How much? That was not an issue given the newness of our "performance-based" training efforts over thr past two-and-one-half years. To better understand the questions of expectation and adequate improvement, one has to know where the standard, or baseline, exists. We now know where CECo's baseline exists, and subsequent improvement measures may be developed from this point.

The question of "bottom-line" dollars is an implication that builds upon the results of this research. The next step, or "Phase Two" of the project, is to incorporate these data and methodology into research designed to correlate human performance (as impacted by training) with plant performance. The corresponding correlations should yield bottom-line data regarding cost-effectiveness and training programs.

VI.5.11

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